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THE THIRTY-EIGHTH ANNUAL CONVENTION

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The program of the 1938 Convention, of the Central Association of Science and Mathematics Teachers, was one of the most inspiring and helpful, I have ever attended. Science teachers who attended will enter their classrooms with renewed enthusiasm and ideas to enrich their work. The new feature of exhibitors' program was especially good. The paper by Prof. N. H. Black of Harvard University on "Recent Advances in Science Research" took us into places where ideas originate and where world famous scientists could be seen at work.

The papers by that inspirational teacher of science, Dr. Morris Meister, on the General Program and the Sectional meetings, were extremely helpful and filled with suggestions for live wire science teachers.

The lecture and demonstration "Words, Wires, Waves" by Dr. J. O. Perrine of the Bell Laboratories at the Friday dinner meeting, was one of the most astounding and spectacular the writer has ever witnessed.

Any science or mathematics teacher, in the middle west, who failed to attend this convention, missed, in my opinion what would be a semester's work in Science Education, in a School of Education—in fact my reaction is that this was one of the best conventions I ever had the privilege to attend. It shows the fine cooperation between the exhibitors of science equipment and the teachers who put on the program. Congratulations to President Davis, the sectional officers and committees for this inspiring meeting.

PAPERS FROM THE ANNUAL CONVENTION

This issue of SCHOOL SCIENCE AND MATHEMATICS is devoted to papers from the Annual Convention of the Central Association of Science and Mathematics Teachers held in Chicago, November 25 and 26, 1938.

The articles selected for this issue are by prominent leaders in the various fields of science and are typical of the high character of all sections of the Association, but others of equal merit and practical value will follow in later issues. The full report of the Convention is given on pages 62-79 by the Secretary, Mr. Harold H. Metcalf, and the Section Secretaries.

THE USE OF ROAD MAPS IN ELEMENTARY ALGEBRA

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In the introduction to the fundamentals of graphing, the writer has found it quite helpful to use a road map to supplement the usual method of first teaching bar graphs. The difficulty encountered in the usual method lies in the transition from bar graphs to line graphs and then to graphs of equations.

The roadmaps have value in that by their use, one can teach the students how to find a point, given the abscissa and ordinate, and on the other hand they can, if given a point, learn easily to give its abscissa and ordinate.

The students are each given a map and are instructed to note the letters printed vertically on the map and numbers placed horizontally on it.

He is given exercises in locating towns, given the call letter and number. Then he is given the name of a certain town and is required to tell what the call letter and number is. The letters are replaced by numbers and he is required to locate towns given the numbers, and then to give the numbers locating towns whose names are given by the instructor.

This practice enables the students immediately to plot points when given pairs of numbers. Or it gives them ability to give the coördinates of points chosen anywhere on the coördinate paper.

Signed numbers can be handled equally well by drawing axes on the map instead of using only the first quadrant as is the case if the left and lower of the map are used as axes.

After this sort of practice, the students have no trouble reading the coördinates of the points of intersection of two linear equations solved simultaneously by graph.

When you change address be sure to notify Business Manager W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.

RECENT APPLICATIONS OF PHYSICS AND CHEMISTRY IN BIOLOGY

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In his *Principles of General Physiology* the famous English physiologist, Sir William Bayliss, in the following words clearly stated the principle which should guide the development of experimental biology and medicine, "We will subject living protoplasm to the test and determine the ways in which it follows known laws and rules of physics and chemistry and if the occasion arises where no rule is followed, note it and study it with the hope of explaining it on known laws." This dictum has become the watchword of modern biology and the striving to reduce biological phenomena to quantitative description has been responsible for most of the great successes of contemporary biology and medicine.

There can be no doubt that this quantitative physical-chemical approach has led to great control of man over his environment, particularly in the field of medicine, and as such is clearly worth all the effort and expense which it has cost. The fact that medical science is still highly empirical is not to be wondered at since medical science must necessarily be built upon the foundations of general biological science. Before we can hope to understand and correct the diseased organism we must first understand the physiology and general biology of the normal organism. And, just as medical science looks to biology for theoretical and technical guidance, so biology looks to the simpler, more "fundamental" sciences of chemistry and physics. There may be legitimate reasons to doubt that this analytical physical-chemical approach to biological science is the only, or even the most profitable one. We shall consider this question in more detail later. I wish at this time to call to your attention some of the recent important contributions to biological science which have come from the analytical method of approach through the application to biology of theories and techniques of chemistry and physics.

The particular recent advances which I have chosen to discuss illustrate in a striking way a fact which is to a large extent responsible for the extremely rapid expansion of modern experimental biology. This is the fact that the time lag between the

development of a new physical or chemical theory or technique and its practical application in biology has been greatly reduced. At least three factors are responsible for this highly desirable situation. First, the present generation of biologists is sufficiently well trained in physics and chemistry to understand the significance of new developments in these fields and their possible bearing on biological problems. Second, the physicists and chemists are themselves more keenly aware of the bearing of their work on the problems of biology than previously; indeed the professional physical and chemical societies have formed sections on biophysics and biochemistry and have for some years included papers and symposia on these subjects on the programs of their regular meetings. Finally, through the medium of journals which publish papers in the borderline fields, and of a number of periodicals on general science which have a wide circulation and are read by people interested in various fields, new discoveries are given rapid publication, thus facilitating their early application in other fields.

We may begin our discussion with some applications of thermionics and the techniques which were developed primarily for use with radio and television.

One of the universal characteristics of living cells is the electrical polarization which exists across the cell membrane and the fact that when a tissue becomes active, electric potential differences are set up between the active and the inactive regions. This was discovered about a century ago by du Bois Reymond. Using a relatively crude moving coil galvanometer he showed that as the wave of contraction sweeps down a muscle or a wave of excitation sweeps down a nerve the activity is accompanied by a wave of electrical potential difference. However, the activity at any point lasts for only a few thousandths of a second and the wave moves down the tissue with velocities as high as 100 meters per second. Because of their inertia, du Bois Reymond's moving coil galvanometers were far too slow to follow such fast waves. Even the more recently introduced string galvanometer is too slow for such purposes. The whole field of electrophysiology was tremendously expanded by the application of vacuum tube technique for the measurement of tissue potentials.

Some fifteen years ago Gasser and Erlanger of Washington University introduced the cathode ray oscillograph technique for recording such potential waves. In the electron oscillograph

tube, which is the type used in television, an electron gun shoots a beam of electrons through the evacuated tube and where this beam strikes the fluorescent screen in the front of the tube a bright greenish yellow spot is produced. Since electrons bear a negative charge, the beam can be deflected by placing an electric potential on a pair of plates between which the beam passes, and the amount of deflection is proportional to the voltage on the plates. The inertia of an electron beam being negligible, the oscillograph tube is capable of recording changes in potential which are extremely rapid. Unfortunately the tube is relatively insensitive and nerve or muscle potentials are too small to affect it directly. Gasser and Erlanger therefore borrowed another technique from radio, namely, the amplification of voltage by vacuum tubes. By using a three tube amplifier they were able to boost the voltage of the nerve to the point where it would activate the oscillograph tube and they thus obtained the first accurate photographs of these fast potential waves in nerve.

Since then the oscillograph has been almost universally adopted for such work and its performance has been tremendously improved by the use of more efficient amplifiers. As improved vacuum tube designs and circuits are introduced into radio technique the electrophysiologist makes use of the improvements by adapting them to the oscillograph. The enormous development in this field is indicated by the fact that the entire electrical equipment for a modern oscillograph can now be placed in a few small shielded boxes, whereas in the early experiments of Gasser and Erlanger a whole room full of apparatus was required.

Application of the technique to physiology has revealed many new facts about how nerves and muscles function. One of the latest applications is in recording electroencephalograms, the so-called "brain waves." The brain, being a nervous organ, also produces electric potential changes during activity. These potentials can be picked up from wire electrodes placed in the scalp, and the waves recorded on the oscillograph. Of course the potentials are greatly reduced by the resistance of the bone and other materials which lie between the brain and the electrodes but even these minute potentials can be faithfully recorded. Since the brain is a very complex organization of nerve cells and tracts, with impulses passing in all directions, the potential picture shown on the oscillograph is correspondingly complex and hardly a beginning has been made in the interpretation of

the various waves and rhythms which are recorded. However, progress is being made, particularly with the interpretation of effects in the visual and auditory pathways and the prospects are so good that psychologists have taken an active interest in the field and many laboratories throughout the country are using the technique to learn more about the way in which the brain acts. The method has also been of use in medicine, particularly in the study of epilepsy for epileptic seizures produce characteristic alterations in the electric manifestations of the brain.

A new modification of the electron tube which promises to be of enormous importance in biology is the electron microscope. The ordinary microscope can never reveal objects which are smaller than about half the wave length of light. With visible light this is about 0.0002 mm. and with ultraviolet light about 0.0001 mm. Now the ultimate particles or building stones of which tissues are made, as well as the viruses which produce certain important diseases, are considerably smaller than this and to reveal these we need useful magnifications ten to fifty times the maximum possible with the ordinary microscope.

Some years ago physicists began to think that although the electron is a particle of negative electricity it also has some of the wave properties characteristic of light. A beam of electrons could therefore be considered like a beam of light except that its wave length is from 1000 to 100,000 times smaller than that of visible light. If a microscope could be constructed using an electron beam instead of visible light it would therefore have 1000 to 100,000 times the magnification of the ordinary microscope. Now since the electron is a charged body it can be deflected by a magnetic or electrostatic field and this makes the electron microscope possible, for in place of the objective and ocular lenses of the ordinary microscope one uses electromagnetic coils or charged condenser plates in the electron microscope. The electron rays coming from the object to be examined are thus bent and focused in a manner analogous to that in an ordinary microscope and the image may be seen on the fluorescent screen at the end of the tube. Magnifications five to ten times that possible with the ordinary microscope have already been obtained and as the technique is perfected we can expect even much higher resolution.

Unfortunately the biological application of the method is severely limited by the fact that the object must be thoroughly

dried, placed in a high vacuum, and bombarded with high velocity electrons which have a destructive effect on organic substances. However, as the method is developed at least some of these difficulties will undoubtedly be overcome and a vast new field will be opened in biology and medicine. Already very highly magnified pictures of bacteria and other cells have been obtained by several German workers and structures previously unsuspected have been revealed within the cells. Using a modification of this technique Dr. Scott at Washington University has discovered important facts about the distribution of calcium in various animal cells and tissues.

The rapidity with which difficult physical techniques are put at the service of biology is shown by the fact that now, scarcely more than ten years after the mere theory of electron optics was conceived by physicists, fully assembled electron microscopes can already be bought from certain German manufacturers.

While the electron microscope offers the only method of obtaining actual direct visual evidence of the submicroscopic structure of cells and tissues, there are other methods of an indirect sort which have been in use for a considerable time.

If the molecules of which tissue structures are made are arranged in orderly oriented configurations they will show the phenomenon of double refraction and this can be detected by polarized light methods. Work of this sort has been going on for almost a century and important information about tissue fine structure has been obtained. But in recent years the method has been greatly improved so that it is now possible to detect and analyze the double refraction of extremely small cellular objects in which no double refraction had previously been observed. Thus we are beginning to learn about the molecular organization of chromosomes, spindle and astral fibers, nuclear and cell membranes, etc. And these observations can be made on the living, functioning cells without imposing grossly artificial conditions.

Another very powerful aid in working out the molecular basis of cell structure is the method of X-ray diffraction. The tissue, such as a muscle or nerve, is placed in a strong beam of monochromatic X-rays, the emerging rays being allowed to strike a photographic plate placed some inches away from the tissue. If the tissue contains molecules which are highly organized so as to form almost crystalline arrays, there will be on the photo-

graphic plate, aside from the central spot caused by the primary beam, a number of other spots produced by reflection of the rays from the regularly oriented molecular planes in the tissue. From such patterns one can calculate the dimensions and configurations of the oriented molecules in the tissue. Very valuable information has already been obtained from this method about the structure of the protein contractile mechanism of muscle, the molecular organization of nerve fibers, bones, tendons, skin, hair, etc.

It should be pointed out that until such information about the molecular structure of tissues and cells is obtained the physiologist can hardly expect to learn how the tissues and cells function. It is like asking a mechanic to discover how a new type of automobile works without allowing him to lift the hood and examine the construction of the engine, the drive shafts and the gears. Histologists have exhaustively examined tissue and cell structure with the magnifications available with the microscope. To push the analysis further and to examine micellar and molecular structure we must turn to the physical methods just mentioned. This represents one of the most important and promising fields of modern biology.

Before leaving the subject of physical techniques we should mention the very promising possibilities that have been opened up by the new technique of artificial radioactivity. Physicists have constructed devices such as the cyclotron and electrostatic generator by means of which very high intensity beams of protons, deuterons or neutrons can be produced. If such a beam strikes an atom it may cause rearrangements within the nucleus such that the atom becomes radioactive, giving off high speed electrons or other particles and being transformed thereby into a new element. For example, if phosphorus in the form of sodium phosphate is thus radiated, a fraction of the phosphorus atoms will become radioactive. This can be proven by placing the radiated phosphate crystals in front of a Geiger-Mueller tube, which is a sensitive device for the detection of ionizing radiations. The result will be a volley of clicks from the instrument, indicating the presence of radioactivity in the phosphate incident to its transmutation into sulphur. Two points about this process must be appreciated. First, the radiated atoms behave chemically exactly like unradiated atoms. And secondly, the artificial radioactivity lasts only for a certain length of time, decaying in intensity and finally vanishing. In the case of phos-

phorus, the radioactivity subsides to half intensity only after a period of about two weeks.

We are thus able to tag or label the phosphorus atoms mentioned in this illustration, by bombardment with the high velocity particles emitted by the cyclotron. Such radioactive phosphate can then be fed to an animal and the distribution of the labeled atoms in the various organs and tissues followed by means of the Geiger-Mueller detecting device. In this way radiolabeled phosphate has already been traced from the digestive tract into the blood and thence into the structure of the brain, bones, teeth, muscles, etc., and many surprising new facts have been learned which have an important bearing on biology and medicine. In the short space of about two years facts of importance have been learned regarding such clinical conditons as rickets, anemia, lipemia, and leukemia, Some enthusiasts have claimed that the technique of radiolabelling may prove to be as important in biology and medicine as was the invention of the microscope.

I should like to say a few words also about some of the recent advances in chemical theory and technique which have an important bearing on biological phenomena. Since there is space for but a few of these I shall restrict myself entirely to one field, namely the great strides which have been made recently in the determination of the structure, chemical composition and properties of the proteins and their complexes. Since the enzymes as well as most of the cellular structures are composed of proteins the importance of such work is obvious.

It has long been known, of course, that proteins are high molecular weight compounds but it has been only comparatively recently that accurate methods have been devised to determine their molecular weights. Data obtained with the analytical ultracentrifuge as well as with the methods of electrophoresis, diffusion, osmotic pressure, X-rays, etc., have shown that some of the proteins are veritable giants, having molecular weights in the millions. It is now claimed that the viruses which cause certain diseases such as rabies, infantile paralysis, influenza, yellow fever, sleeping sickness (encephalitis) etc., are in reality certain specific proteins which can be isolated, crystallized and analyzed. The enormous size of some of these virus protein molecules makes the very meaning of the term molecule vague. Some idea of the size and complexity of such molecules may be gotten by comparing one of them with a simple molecule like

water. Even some of the simpler virus molecules would compare in size with a water molecule like a superliner such as the Queen Mary would compare in size and weight with her captain. There is little wonder that from such enormous size and complexity may come such highly specific chemical and biological properties as characterize the viruses, the enzymes, and perhaps the determiners of heredity, the genes.

Now since even the most complex protein is constructed by the combination of some twenty to thirty different sorts of the amino acid building stones, it is obvious that the chemical and biological specificity of the proteins must reside in the specific pattern or geometry according to which the organism, as the architect, has combined the various amino acid building stones. This seems obvious but it has been only recently that methods have been refined to the point where some of the simpler proteins can be analyzed chemically and the relative percentages of the various amino acid ingredients determined. Using such improved methods, Bergmann, at the Rockefeller Institute has brought to light a most interesting fact. Not only has he determined the recipe, so to speak, of some of these proteins but he has brought chemical evidence to show that the various amino acids probably occur in a certain definite linear order in the molecule; an amino acid of type A is followed by one of type B, followed by one of type C, etc—until all of the types of amino acid building stones are accounted for in a long string-like molecule. This long string may be greatly coiled upon itself to form an ellipsoidal structure under normal conditions. It may confidently be hoped and expected that further molecular cartography of this sort will lead to the discovery of chemical reasons for the specificity of the proteins as illustrated in enzymatic processes, in immunology, and possibly even in the determination of heredity and development.

Before closing the discussion of the proteins I should like to say a few more words about enzymes. We now know that probably all reactions which lead to energy liberation in the organism are catalyzed by e.g., are made to proceed through, the mediation of enzymes. This is true whether the reaction be one of oxidation or reduction, hydrolysis or synthesis. Obviously the chemistry of these enzymes is therefore at the basis of all vital phenomena, and recently much information has been gathered about their chemical properties. Some enzymes, particularly those mediating hydrolyses, such as pepsin, trypsin, urease, etc.,

appear to be exclusively protein, and some of these have been crystallized in pure form and their properties described. Other enzymes, particularly those mediating oxidations and reductions, are complexes consisting of a protein molecule plus a much smaller group such as a hemin or flavin group. The small molecule is the active group and actually causes the electron transfer in oxidations and reductions to take place. The protein molecule is the carrier for the active group and determines the specificity of the enzyme, e.g., that it shall promote the oxidation of only one given substance to the exclusion of almost all other substances. The recent work of O. Warburg and others in proving this and in demonstrating the chemical nature of several of the most important active groups stands as a milestone in the application of chemistry to one of the most fundamental of vital phenomena. The work is also of immediate importance in medicine for it has already been shown that several of the vitamins and hormones operate in conjunction with such coupled enzymatic systems.

With these examples from current research which I have briefly and, I am afraid, inadequately, outlined I have meant to give you a glimpse of the modern trend in experimental biology and medicine—to show you how thoroughly the present generation of biologists is following the principle so well phrased by Bayliss in the passage quoted at the outset. We work by a method of abstraction. Our approach is almost entirely analytical. To study the phenomenon of muscle contraction we dissect the muscle from the animal and study its properties under controlled conditions. We even extract from the muscle the protein which we think is responsible for the contraction and try to show why such molecules should shorten or produce tension. And if someone challenges the wisdom of our philosophy of approach, like the politician, we point with pride to the record of our achievements. There can be no doubt but that more has been accomplished in the last twenty five years toward an understanding of the mechanism of individual processes in the organism, like muscle contraction, nerve conduction, glandular secretion, etc., than was accomplished in all the past. We can certainly point with pride to what the method has done for medicine. Think what the life expectancy is today compared with what it was fifty years ago. We are living in an age of technology and biology and medicine are trying to keep step with the times.

However, biologists are by no means unanimous in the opinion that so much emphasis should be placed on the analytical technical method of approach. In fact we are beginning to hear voices crying in the wilderness in vehement protest. These people believe that biology should not be so dependent on physics and chemistry but should be considered a science in its own right. They do not wish to replace mechanism with any futile and nebulous vitalistic speculations, but rather with the doctrine of organicism, the keynote of which is that the organism is an indivisible unit and that by sacrificing this unitary organization, the analytical method blinds us to the most important properties and characteristics of the organism. Some of the apostles of organicism, like Bertalanffy, go so far as to say that had biology grown up freely, unperturbed by chemistry and physics, it would be better developed today. Thus Bertalanffy says: "Growing up under the shadow of physics it (biology) has languished like a plant deprived of light. If this inhibition is removed the originality and precision which it could not attain under so powerful an influence will present themselves in due course." Some go even further and say that general adoption of an organismic viewpoint in practice as well as theory would counteract the general disregard of the individual and his personal liberties, which has been one of the unfortunate results of the application of the spirit of technology to social problems. Pointing to the imminence of a catastrophic general war waged with the utmost of technological precision it is being urged that life sciences mend their ways. Let them discard the mechanistic tenet that life is but a mechanical artifact, hence of little intrinsic value. Let them restore the psyche in psychology. Let them investigate the properties of organisms as revealed in their behavior in social systems and in their adaptation to their environment. Let them develop sociology before that very technology which has added so materially to human comfort and to the ability of man to control his environment, be turned against society and destroy it.

We would not dispute the fact that phenomena are shown by the organism in its relation to its environment which can be investigated only by the organismic method, that these phenomena may be of utmost significance in biology and in their application to human affairs, and that they are not being investigated as thoroughly as they deserve at the present time. We must also admit that the modern physico-chemical biolo-

gist looks with a certain amount of condescension upon his colleagues who restrict their activities to such organismic problems; their failure to use quantitative analytical methods is regarded as due either to poor training in physics and chemistry or just to plain stupidity. We must further admit that some recent triumphs in biology have been obtained without benefit of quantitative methods. For example, the modern school of experimental embryology has arisen through the work of men like Spemann and Harrison, without particular reference to physical chemical theories or techniques. This work has had a profound effect not only on theories of development but on genetics as well. The particulate gene theory of heredity and development arrived at by geneticists from abstract analytical reasoning has been shown to be inadequate and modern embryology has substituted an organismic unity theory according to which the genes play only a partial role; it is the organization of the whole system which guides the orderly processes of development and heredity.

What shall we say then in answer to this indictment of the analytical method? Shall we allow it to act as an effective immunization against that very virus with which I have tried to infect you in the previous portion of this presentation—the virus which Bayliss and his kind injected into my generation of biologists—the virus which produces in the victim the insatiable desire to reduce biological phenomena to the simplest quantitative description in terms of physics and chemistry?

Again we turn to Bayliss for sane counsel. On the fly leaf of his textbook is a Greek inscription expressing the admonition of St. Paul to the Thessalonians: "Prove (test) ALL things, hold fast that which is good (true)." By all means let us investigate organismic phenomena wherever they may be found. Let us strive to bring to light any processes or phenomena which appear to be unique to organisms and to be manifested in no less complex physical-chemical system. I once heard a famous physicist remark that physics must eventually look to biology for its further expansion. In this statement he expressed his belief that organisms are the seat of phenomena undreamt of in our present day natural philosophy and that when biologists discover these phenomena, physicists will be presented with rich new fields for their labors.

But though we prove or test all these things how shall we know what is good or true, that we may hold it fast? Surely

the only way is by striving to fit all the facts into a unified body of natural science, by explaining the complex phenomena in terms of simpler laws based on chemistry and physics. Once the new complex emergent phenomena have been discovered by the organismic method I have the utmost faith that they will eventually yield to analysis by the quantitative application of physical and chemical principles. The organismic method is therefore not opposed in principle to the analytical method. Its chief purpose is to provide ever expanding horizons of natural phenomena, to reveal new territory which must then be explored and surveyed by painstaking quantitative methods and with the tools provided by chemistry, physics and mathematics.

While we are still far from understanding the mechanisms underlying even the simplest physiological phenomena which have already been discovered and we could doubtless go on for generations increasing our knowledge of these partial phenomena, it is perhaps salutary that we be reminded from time to time to lift our eyes beyond these small confines and to be ever more deeply impressed by the vast expanses which lie beyond. And if it be necessary in the interest of the preservation of the race to place more emphasis on the social sciences let that be done with all the means at our disposal. But in so doing let us continue wherever possible to use the tools given to us by the simpler sciences, for they are the means by which we can test all these things and hope to arrive at some truths or partial truths which we can hold fast.

RECKLESS KILLING OF GAME CAUSES TROUBLE IN TANGANYIKA

Tanganyika Territory, prominently mentioned as a possible homeland for exiled Jews, is already having difficulties with the relatively few European settlers there because of their reckless killing of big game, reports S. P. Teare, principal game warden of the territory.

Recently, a considerable number of hunting licenses were issued to white residents. They were immediately abused, in that, instead of using them for sport, the holders took advantage of their privileges to kill animals on a pot-hunting scale, as food for native workmen in mines, on plantations, etc. Mr. Teare expects big game to be exterminated in wide belts around these large European holdings unless the practice is stopped.

Elephants have suffered from hunters' onslaughts, too. During 1937, 1,481 of the great beasts were slaughtered for their ivory, of which 37,380 pounds were exported.

Mr. Teare also reports the establishment of a new big-game preserve in one of the less exploited parts of the territory. It covers an area of about 2,000 square miles, and offers refuge to elephant, hippopotamus, buffalo, and several species of antelope.

MATERIALS AND EQUIPMENT FOR THE TEACHING OF ELEMENTARY SCIENCE

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Teachers of Elementary Science, more than other teachers of science, are placed in a great variety of bewildering situations. There are those who are expected to carry on with only their conscience as a guide. There is no organized course of study. There are, on the other hand, those who must follow an elaborate course of study, yet no provisions are made for teaching aids. Those who have taught, know that the constant appeal made to the interests of the children is often more significant than subject matter, well selected and organized.

In most cases, the grade teachers are more or less on their own in obtaining materials. It is true that because the subject is centered around the interests of the children in the factors of their immediate environment, much of the materials for study will be brought in by the children themselves. But there are many times when it is necessary to enrich and vitalize the course with references, visual aids, and simple apparatus which cannot be provided by the children. It is at such times that the teacher will find this compiled list of materials helpful. When there is no course of study provided, becoming acquainted with the outstanding courses of study given here will serve as a guide in organizing suitable teaching material. If it is not out of turn, I would like to state at this point that I do not believe it is necessary for every school to make its own course of study. Both the fundamental truths of science and boys and girls are the same the world over. There are outstanding schools provided with teachers who are leaders in the field of elementary science and an organization which is flexible enough to provide for testing and placement of materials at the proper grade levels so that a course of study under such conditions can be scientifically built. Courses of study from such schools should be recognized and accepted with, of course, necessary modifications and adjustments to local conditions by other schools; and the time which would otherwise be used in developing a course of study could be more profitably used to enrich and vitalize materials and methods of teaching.

The list of children's books on the various topics such as

birds, trees, animals, etc., to date is too long to be included here. Only a few of the best, cheapest, and most available are listed. Instead, sources for obtaining such compiled lists have been given. It might be well to suggest at this point a few selected references which teachers will find helpful in developing for themselves a background and philosophy in their teaching:

Handbook of Nature Study.....Anna Botsford Comstock
Science in the Elementary School.....W. C. Croxton
Science in General Education.....
.....Report from the Progressive Ed. Asso.
The Child and the Universe.....Bertha Stevens
Almanac for Moderns.....Donald Peattie

It is suggested that some system of filing be used whereby it is possible to add to this compilation further materials in the form of stories, pictures, clippings, and references which may be discovered from time to time.

If the school does not provide a science room for the grades, then every room should have a science corner with a nature study table, and shelves for those specimens which have been contributed toward a room museum. There should be a cage for live material, window boxes for plants, seed or germinating boxes for growing things, and an aquarium for water plants and animals. Mayonnaise jars of uniform size carefully labeled make excellent containers for museum specimens. A very cheap but effective preservative is a formaldehyde solution (6 parts of water to 1 part of formaldehyde). Leaves and flowers for a permanent room collection should be pressed, shellacked, mounted on cardboard, labeled, and covered with cellophane. Shellac also makes a permanent preservative for seeds (tree and weed), galls, wasp nests, spider egg cases, cocoons, twigs, bird's nests, etc. There should be labeled boxes in which to keep magnets, iron filings, hand lens, and mechanical equipment. The science corner or science room should not look as if some one had just driven in and tipped over. Science is *organized* common sense. Organization should be stressed throughout. Materials should be properly grouped and labeled. They should be materials which are useful and not just for show.

The science room which has been worked out in the most successful schools in the country is a cooperative Science room—one room which is used by all the elementary grades. Such a room is equipped with dark shades and a projection screen, a

large waterproof demonstration table with running water, sink, and outlets for electricity and gas. There are tables and movable chairs for the students. There are filing cases, book shelves, an aquarium and terrarium, window boxes, equipment for simple experiments, charts, and exhibits. Such a room is equipped with teaching material for all grades, and those who use it are responsible for leaving everything in proper order. The room is open at all times and every child is made to feel a responsibility in contributing materials or sharing in the care of those materials already provided.

The students should be permitted to make their own lantern slides and room charts. There is an advantage here in that it is possible to have more of them and that they are within the scope of the child's understanding. (This is not always true of prepared ones.) This work also teaches the child accuracy in observing details.

Some rooms may be properly located where it would be possible to have a bird feeder outside the window in the winter or an observation beehive in the spring and early fall. For inside study, an observation ant's nest on the nature study table would provide both information and entertainment.

The students might find it interesting to raise their own meal worms and earth worms to feed such animals as salamanders, horned toads, and lizards during the time when it is impossible to catch flies and other insects for them. The *Turtox Teachers' Manual* provides instructions for growing this material. (May be obtained at the following address: General Biological Supply House, 761 East 69th Place, Chicago, Illinois.)

During the winter months, the study of animal tracks will be more interesting if the students are given the opportunity to reproduce some of them in modeling clay or plaster or Paris. These models may then be added to the science museum shelves to be later used in comparing and identifying animal tracks.

The "tin can telescope" always adds interest to the study and identification of constellations. These are easily made. With a nail to make the holes in the bottom of the tin can to represent the different stars in the group and a flashlight inside the can to provide the light, these miniature constellations make it easy to locate and identify the real constellations.

In the study of weather and seasons, there should be a shadow stick, barometer, rain gauge, and weather vane. Simple instructions for making these are found in almost any general science

text. Five and Ten Cent Store materials can be used for the study of gears, pulleys, levers, and inclined planes.

Trips to the zoo, museum, local industries, field trips to study local plants and animal life are all quite as important as classroom instruction. This part of our teaching is too often slighted because it breaks the routine and requires too much effort to make the proper preparations for such a lesson.

Most of the evils in the use of materials for the teaching of science in the past has been due to the fact that these materials

which should have been the aids to better teaching have been not aids to real understanding, but a source of curiosity and entertainment only; and that which was meant as a means to a greater end of increased interests, understanding and abilities was misused as an end in itself. Equipment should be an instrument which aids the child to learn through doing—to find out for himself how it works.

It is not intended that this compilation should be used as a guide, but as a stimulation to better teaching through an increased knowledge in where to find useful teaching aids where it

is necessary to inject vitamins into your teaching to promote growth and development in interest and understanding.

We hope you will find the materials listed here sufficiently organized that they will speak for themselves. In closing, let me say that if you find these suggestions a *real* aid in obtaining helpful materials for better teaching, then the committee will feel amply repaid for their part in preparing them for you.

ACKNOWLEDGMENT

Appreciation is extended to the following who made helpful contributions.

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BIRDS

Pictures and charts—

F. M. Baker Apparatus Co., Syracuse, N. Y. Bird pictures in color. Send for catalogue of prices.

J. L. Hammett Co., 380 Jeffiff Ave., Newark, N. J. Outline drawings of birds. Send for catalogue of "School Supplies" for prices.

Singer Sewing Machine Co., 149 Broadway, New York City. A set of bird and bird's egg pictures in natural colors. *Free.*

Audubon Societies, 1974 Broadway, New York City. Audubon bird wall charts. $2.50 each. 50 colored pictures (post card size) with habits and distribution on each. "Pocket bird collection," set of 4 at 10¢ each. Small charts of birds in color arranged according to migratory habits.

Church and Dwight, 27 Cedar St., New York City. Two colored wall charts showing native birds. *Free.*

Motion pictures—

Bray Production, Inc., 729 Seventh Ave., N. Y. City. "Children of Nature," 1 reel showing how young birds are brought up. Rent. "Song Birds as Citizens," 1 reel on familiar song birds shown at close range. Suggestions on their preservation and how to make friends with them. Rent.

Edited Pictures System, Inc., 130 W. 46th St., New York City. "Native Birds," 1 reel on birds showing adults, nests, eggs, and young. Rent.

Clubs—

Junior Audubon Club. National Association of Audubon Societies, 1974 Broadway, New York City.

Special Leaflet No. 22. *Free.* An announcement to teachers giving rules on forming clubs, list of books and supplied for bird study.

Books—

National Geographic Society, Washington, D. C. "The Book of Birds," 1937. $2.50.

Whitman Publishing Co., Racine, Wisconsin. Outline book on birds for coloring. 10¢. Red, green, and blue handbook of birds. 10¢.

The Harter Publishing Co., Cleveland, Ohio. Blue, red, and yellow handbook of birds. 10¢. (The Harter and Whitman books may be purchased at any ten cent store.)

Magazines—

Bird Lore. National Association of Audubon Societies, 1775 Broadway, New York City. $1.50 per year.

INSECTS

Exhibits—

Corticelli Silk Mills, Florence, Massachusetts. A silk culture cabinet, $2.00.

H. K. H. Silk Co., 120 E. 16th St., New York City. Contains all the stages of the moth and steps in the manufacture of silk thread accompanied by a booklet of explanation. Comes in two sets: No. I, $2.50; No. II, $1.00.

Pictures and charts—

Corona Chemical Co., Milwaukee, Wisconsin. Insect pests and plants they attack, in color, accompanied by book, "Garden Pests and Their Control." *Free.*

U. S. Public Health Service, Washington, D. C. Chart 16″×20″ in colors. Picture information on diseases caused by the fly. Means of extermination. *Free.*

Motion pictures—

Church and School Film Exchange, 315 Polk Bldg., Des Moines, Iowa. Rent. "History, Life and Habits of the Silk Worm." 1 reel. "Insects that Mimic." 1 reel. "Insects that Sing" such as the cricket, etc. 1 reel.

Bray Production, Inc., 729 Seventh Ave., New York City. "Fly as a Disease Carrier." 1 reel on how the house fly carries disease. Means of extermination. Rent.

Pinkney Film Service Co., 1028 Forbes St., Pittsburgh, Pa. 'Dexterity and Mimicry of Insects." 1 reel on the remarkable ability of insects to outwit their foes. Rent. "Giants of Industry." 1 reel showing the strength of flies and ants. Rent.

Pictorial Clubs, Inc., 35 W. 45th St., New York City. "Singing and Stinging." 1 reel that gives a fine microscopic presentation of the life and destruction of the mosquito. Rent.

Educational Film Exchange, 1501 Broadway, New York City. "The Ant."1 reel showing the structure of an ant hill and the life history of the ant. Rent.

Pathe Exchange, Inc., 35 W. 45th St., New York City. "Ants, Nature's Craftsmen." 1 reel showing the life cycle, homes and activities of ants. Rent. "Honey Makers." 1 reel showing the life history of bees and their work showing remarkable close-ups of these creatures about their tasks. Rent.

De Frenes and Felton, Wilkes-Barre, Pa. "The Butterfly." 1 reel showing the various stages in the life history of this creature from egg to full grown adult. *Free.*

Pamphlets—

F. E. Lutz. Guide Leaflet No. 39.

American Museum of Natural History, 77th. St. and Central Park West, New York City. "How to Collect and Preserve Insects." 10¢.

Merit Badge Series, Boy Scouts of America, 2 Park Ave., New York City. "Insect Life." 240 pg. book with chapters on identification

collecting, life histories, etc. Clear illustrations, tables, and good bibliography. $1.50.

Books—

"Our Insect Friends and Foes and Spiders"—Grosvenor National Geographic Society, Washington, D. C. Pictures are excellent for both children and adults.

"Grass Root Jungles"—Teale. Dodd, Mead, and Co., New York. 1937 ed. $3.75. Very readable and beautifully illustrated.

Whitman Publishing Co., Racine, Wisconsin. "Bugs of America," 10¢. "Butterflies of America." 10¢. (Colors are not the best but good enough for identification.)

"Insect Oddities"—Ditmar and Carter. Lippincott. Publisher. 1938 ed. $1.75.

Silk worm eggs which will grow into real silk worms may be obtained 300 for 25¢ from T. A. Kelleher, P. O. Box 82, Washington, D. C.

OTHER ANIMALS

Exhibits—

U. S. Rubber Co., 1790 Broadway, NewYork City. "Animal Tracks." Footprints of different kinds of animals made directly from the paws of animals themselves pressed into soft clay. Individual prints of smaller animals. 35¢. (Write for information and other prices.)

Motion Pictures—

First National Pictures, 383 Madison Ave., New York City. "The Lost World." Thrilling story of a scientific expedition of living dinosaurs on an inaccessible plateau in the Andes Mts. Rent.

Neighborhood Motion Picture Service, 131 W. 42nd. St., New York City. "Film Lessons in Nature Study." A series of reel lessons. Rent. "Sky and Clouds." "Worlds too Small to See." "Laws of the Animal World." etc.

Carter Cinema Producing Corp., 55 Fifth Ave., New York City. "Oyster Industry," 1 reel on how and where oysters grow and how they are prepared for market. Rent.

Film Classics Exchange, Fredonia, N. Y. "She Blows." 1 reel on whale hunting. Rent.

Standard Film Service Co., 600 Film Bldg., Cleveland, Ohio. "Sponge Fishers." ½ reel on how sponges are obtained and marketed. Rent. "Pigmy Circus." 1 reel showing turtle, lizard, chameleon, walking leaf, etc. Rent.

Pinkney Film Service, 1028 Forbes St., Pittsburgh, Pa. "Water Babies." 1 reel showing the creatures that take to the water. Those that leave the water when grown. Those which are permanent dwellers. Rent. "Life Functions of Animals" (the frog). 1 reel showing the life of the pollywog and metamorphosis of the full grown frog. Rent. "The Four Seasons." 4 reels showing most remarkable adjustment of animal life to different environment from season to season. Done under the direction of R. L. Ditmars. Rent.

Bray Production, Inc., 729 Seventh Ave., New York City. "Hands vs. Feet." 1 reel showing the comparison of the use of hands and feet by and animals. Rent. "Fathoms Deep." 1 reel showing the miracles and tragedies of sea life—sea anemone, star fish, octopus, etc. Rent.

Better Service Film Co., Inc., 116 S. Salina St., Syracuse, N. Y. "Adaptations." 1 reel showing adaptations of various life forms to their surroundings. Rent.

Edited Pictures System, Inc., 130 W. 46th St., New York. "The Beaver." 1 reel showing the beaver cutting logs, taking them to build his home, etc. Rent. "Our Farmyard Friends." 1 reel showing domestic animals of the farm. Rent.

Pamphlets—

General Biological Supply House, 761 E. 69th Place, Chicago, Ill. "Starting and maintaining aquaria and vivaria." Gives valuable hints on how to keep living things in the classroom. *Free.*

Books—

"The Museum Comes to Life"—Cormack and Alexander. A. Book Co., New York. 1931, 76¢. (A book that delights both young and old.)

"The Shell Book"—Rodgen. Doubleday, Page, and Co., Garden City, N. Y. (An old book but one that is still good to help children in identifying shells.)

"Along the Brook"—Fuller. 1931, $1.50. John Day Co., New York. City (Common animals found in pond and stream.)

"The Reptile Book"—Ditmars. 1937, $5.00. Doubleday, Doran and Co., Garden City, N. Y. (Beautifully illustrated.)

"Wild Animals of North America"—Holzworth, 10¢. Whitman Publishing Co., Racine, Wisconsin.

PLANTS

Exhibits and charts—

Barbour Products. The Linen Thread Co., 200 Hudson St., New York City. "Flax Manufacture." Cabinet showing the full process of flax manufacture with actual specimens. Details secured upon application.

American Nature Association, 1214 Sixteenth St., N. W., Washington, D. C. "Outdoor Good Manners." Bulletin No. 20A. Reprint from the *Nature Magazine. Free.*

American Forestry Association, 1523 L. St., N. W. Washington, D. C. "How a Tree Grows." "Plant a Tree." Posters are 9″×12″ and *free.* U. S. Forest Service, Washington, D. C. "How You Can Help Protect the Forests." A poster especially for Arbor Day. Other posters are available. Free.

The Wild Flower Preservation Society, 3740 Oliver St., N. W. Washington, D. C. "Spare the Flowers." *Free.* Other cardboard posters on "outdoor code" and cartoons. 2 for 5¢.

Motion pictures—

H. S. Brown, 806 S. Wabash Ave., Chicago, Ill. "The Bounty of Nature." 1 reel which is a scenic film of rare beauty showing how nature gives all and withholds nothing. Rent.

Central Film Co., 729 Seventh Ave., New York City. "A Day With John Burroughs." 1 reel showing the great naturalist as he introduces two children to the wonders of nature about his home. Rent.

Edited Pictures System, Inc., 130 W. 46th St., New York City. "Do You Know Beans?" 1 reel showing the germination and growth of the bean from the time of planting to maturity. Rent.

Church and School Film Exchange, 315 Polk Bldg., Des Moines, Iowa. "Seeds and Seed Dispersal." 1 reel of the most remarkable films of the kind. Development of the flower and seed by timed camera exposure. Rent. "Watching Flowers Grow." 1 reel showing the development of flowers as shown by slow motion photography. Rent.

Bray Production, Inc., 729 Seventh Ave., New York City. "Spring." 1 reel showing how life begins in the early spring, leaves and flowers sprouting, growing, etc. rent.

Plays—

Wild Flower Preservation Society, 3740 Oliver St., N. W. Washington, D. C. "Save the Wild Flowers." Circular No. 16. (A one act play wherein small children represent the wild flowers which are in danger of extermination, 5¢.)

Clubs—

Wild Flower Preservation Society, 3740 Oliver St., N. W. Washington, D. C. Junior Chapter. Write for special directions for forming a local chapter.

American Museum of Natural History, 77th St. and Central Park W., New York City. Headquarters for school Nature League. An organization with chapters in many public schools. Specializes in distributing living nature material and in giving assistance in arranging for flower shows, nature trips, lectures, etc.

Books—

Knowing Your Trees—Collingwood. (Inexpensive but has excellent pictures, diagrams.) A. Forestry Asso. 1937. $1.00.

Around the Year—Bertha Parker. Whitman Publishing Co., Racine, Wisconsin. 10¢. (A book for coloring. Children can learn through doing.)

Annuals You Should Know—Julius King. Whitman Publishing Co., Racine, Wisconsin. 10¢. (Illustrated. With growing charts and check lists for ready reference.)

Wild Flowers of America—Harvey and Lawson. Whitman Publishing Co., Racine, Wisconsin. 10¢. (Adequate for identification.)

Talking Leaves—Julius King. Harter Publishing Co., Cleveland, Ohio. 10¢. (A very good inexpensive reference on identification of trees.)

Wild Flowers at a Glance—Julius King. Harter Publishing Co., Cleveland, Ohio. 10¢. (Very good for identification.)

The Book of Wild Flowers—National Geographic Society, Washington, D. C., $2.50.

PHYSICAL SCIENCE

Charts and posters—

Weather Bureau, Washington, D. C. Distributed by the Superintendent of Documents. "Cloud Forms." Twelve half-tone plates of clouds on a sheet 20″×26″. 5¢.

Weather Bureau Office, 17 Battery Place, New York City. This or your nearest weather bureau will send a daily weather map you request. *Free.*

American Lead Pencil Co., 220 Fifth Ave., New York City. "How Venus Lead Pencils are Made." A chart showing the process of manufacture and the countries from which the raw materials are obtained. *Free.* Chart 21″×27″. One to each school.

The Barrett Co., 40 Rector St., New York City. "Products Derived from Coal." A chart showing the many products obtained from coal. 11″×16″. *Free.*

Hammermill Paper Co., Erie, Pa. A large picture showing the complete process of paper making. Will also send a series of pictures showing the historical background and modern methods of paper manufacture. *Free.*

Lantern Slides—

Society for Visual Ed., Inc., 327 S. LaSalle St. Chicago, Ill. "Elementary Astronomy." 62 frames. $2.00.

Bray Screen Products, Inc., 729 Seventh Ave., New York City. "Mysteries of Snow." 5 frames which are excellent pictures of snow crystals. 75¢.

Motion pictures—

Standard Motion Picture Service, Inc., 46th St., New York City. "Crystals and Their Beauties." 1 reel on microscopic pictures of crystal formations. Rent.

Y. M. C. A. Motion Picture Bureau, 111 Center St., Chicago, Ill. "Making Telephone History." 1 reel showing the story of the evolution of the telephone. *Free.*

Bray Production, Inc., 729 Seventh Ave., New York City. "Marvels of the Universe." Dewfall. ¼ reel showing the formation of dew and the microscopic appearance of dew and frost. Rent.

New Jersey State Museum, Trenton, N. J. "Mysteries of Snow." 1 reel showing the beauty of snow flakes and different kinds of crystals. *Free.*

U. S. Dept. of Agriculture, Office of Motion Pictures, Washington, D. C. "Clouds." 1 reel showing types of clouds, etc. *Free.*

Books—

Astronomy From a Dipper—Clarke. 1933. $1.25. Houghton Mifflin Co., Boston & New York. (Attractive and with clear diagrams and directions to help in finding constellations.)

When the Stars Come Out—Baker. 1935. $2.50. Viking press. (Excellent charts showing different constellations.)

Seeing Stars—W. B. White. Harter Publishing Co., Cleveland, Ohio. 10¢. (An excellent inexpensive book. Attractive to youngsters.)

The Stars For Sam—Reed. Harcourt Brace. (A book every upper grade child will like.)

Our Common Rocks and Minerals—Fairbanks. Ed. Publishing Co. (An old book but still one of the clearest presentations for older children.)

Among the Hill—Fenton. 1936. 50¢. Reynals and Hitchcock, New York. (A simple little book for primary grade on how rocks are made.)

The Earth for Sam—Reed. *The Sea for Sam*—Reed. Harcourt Brace Publishers. (The best of their kind.)

How the Earth is Changing—Heal. 1930. Follett Publishing Co. (For upper elementary.)

First Book of the Earth—Rugg and Krueger. Ginn and Co., New York. 1936. 60¢. (Contains answers to questions that small children want to know.)

Living With the Weather—Mills. Caxton Press. 1935. $1.50. (How the weather affects us and what we can do about it.)

One Hundred Thousand Whys—Ilin. $1.50. J. B. Lippincott Co., Philadelphia. (A trip around the room explaining everyday chemical and physical phenomena in the home. Upper grade children will like it very much.)

Romping Through Physics—Gail, 1936. Alfred A. Knopf Pub., New York. (A book for upper elementary explaining the physics of common things. Children enjoy it.)

Science Experiences With Home Equipment—Lynde. International Text Book Co., Scranton, Pa. (Simple experiences which any child can do. Giving directions and illustrations.) $1.25.

Prove It Yourself—Gordon, 1932, $1.50. Owen Publishing Co. (Excellent physical experiments.)

Fun With Electricity—Collins, 1935. $2.00. D. Appleton-Century Publishing Co. (For about sixth grade level.)

FOODS AND HEALTH

Samples and Exhibits—

Corn Products Refining Co., Edgewater, N. J. "Corn Products." A set of 12 bottles containing specimens of the products of corn. *Free.*

Northwestern Consolidated Milling Co., Minneapolis, Minn. "Wheat to Flour." 24 samples of wheat in the various stages of manufacture into flour. *Free.*

Commissioner of Immigration, Winnipeg, Canada. "Grasses and Grains." Box of samples of various cereal crops. *Free.*

Morris and Co., Adv. Dept., Chicago, Ill. "Packing House By-Products." Samples of tallow, glue, and other by-products of the meat packing industry. *Free.*

Beech-Nut Packing Co., Canajoharie, New York. "Peanut Butter." An exhibit showing the substances used and the stages in the manufacture of peanut butter. *Free.*

Sheffield Farms Co., 524 W. 57th St., New York City. "What Milk Is." A cardboard quart milk bottle showing the proportions of the substances of which milk is composed and the total calorie value. *Free.*

Lever Brothers, Cambridge 39, Massachusetts. "Soap." An exhibit divided into 3 groups—raw materials, intermediate, and end products. Very good material on the manufacture of soap. *Free.*

Charts and postures—

The A. Medical Association, 535 N. Dearborn St., Chicago, Ill. "Health Posters for Hygeia." Small reproductions from the magazine with suggestions for making and using them. *Free.*

A. Child Health Association, 370 Seventh Ave., New York City. "Posters to Visualize Health." A booklet on what posters are and how to make them, with examples. 12¢.

National Child Welfare Association, 70 Fifth Ave., New York City. "Catalog of Posters." Shows small replicas, many on health topics. Primarily for younger students. *Free.*

National Dairy Council, 307 N. Michigan Ave., Chicago, Ill. "Milk Made the Difference." Posters on rats, dogs, pigs, and chickens showing the effect of a milk diet. 12¢ each.

N. Y. Association for Improving the Conditions of the Poor, 105 E. 22nd St., New York City. Small sheets suitable for posting on the bulletin board, giving outlines, health rules, etc. The society also publishes larger posters and many booklets on health topics. 20¢ for set of 12.

National Ed. Association, 1201 Sixteenth St., N. W. Washington, D. C. Charts—each 22″×28″. Described in booklet called "Health Chart Report." 25¢.

Lantern slides—

Illinois State Food Commission, 431 Dearborn St., Chicago, Ill. Lantern slides with lecture. *Free.*

Society for Visual Ed., 327 S. LaSalle St., Chicago, Ill. "Salt." 20 slides telling the story of the mining of rock salt to the boxing of refined salt. *Free.*

Motion pictures—

Y. M. C. A. Motion Picture Bureau, 111 Center St., Chicago, Ill. "Good Teeth, Good Health." 2 reels on mother takes her children to a zoo as an object lesson on the care of teeth. Doctor shows proper method. *Free.* "Inside Out." 1 reel showing the story of digestion done in animated diagrams. *Free.*

E. R. Squibb & Sons, 80 Beekman St., New York City. "Sunshine From the Sea." Traces the production, uses, and importance of cod-liver oil. *Free.*

Society For Visual Ed., 327 S. LaSalle St., Chicago, Ill. "Getting Acquainted With Bacteria." 1 reel showing the essential facts about bacteria—shape and how they grow. Rent.

National Motion Picture Co., Indianapolis, Ind. "The Rat Menace." 1 reel showing the habits of rats and how they damage property and spread disease, also how to exterminate them. Rent.

Carter Cinema Production Corp., Evans Film Laboratory, 1476 Broadway, New York City. "The Human Eye." 1 reel showing the care and structure of the eye. Rent.

Church and School Film Exchange, 315 Polk Bldg., Des Moines, Iowa. "Building the Twig." 1 reel showing the importance of correct habits and daily living and personal hygiene. Rent.

Pamphlets—

California Fruit Growers Exchange, Box 530, Station C., Los Angeles, California. "Telling Fortunes With Foods." Urges the value of citrus fruits in the diet. Many worth-while bulletins and pamphlets. *Free.*

Borden Farm Products Co., 110 Hudson St., New York City. "Milk For Sound Teeth." Pictures and facts concerning the lime in milk. Other free publications.

WHERE TO GET FURTHER MATERIALS

Live Specimens of Plants and Animals—

General Biological Supply House, 761 E. 69th Place, Chicago, Illinois. Write for catalogue.

Collections of Fossils for Schools—

Ward's Natural Science Est., 84 College Ave., Rochester, N. Y. Write for price list No. 115.

Rocks and Minerals—

Ward's Natural Science Establishment. Write for price list list No. 276.

Planting Your Bulbs—

A. Nature Association, 1214 Sixteenth St., N. W. Washington, D. C. Bulletin No. 31 (Free). Gives illustrations and helpful hints on how and when to plant different kinds of bulbs.

Snowflake photography—

N. Y. Times Magazine, Sunday, March 6, 1927. Consult library files or write to the magazine for copies of these photographs.

Star Maps—

The Youth's Companion, Perry Mason Co., Boston, Massachusetts. A. star map for each month bound into a booklet with directions for use. 10¢.

Nature Books—

Comstock Publishing Co., Ithaca, N. Y. Puts out an excellent list of keys and other nature books from *The Handbook of Nature Study. Free.*

Books for the Elementary School—

Wilson Publishing Co., 50¢. A list of books.

*Cornell Rural School Leaflet, Sept. issue of 1938, Vol. 32, No. 1. Published by the New York State College of Ag. at Cornell University, Ithaca, N. Y. This leaflet is titled "Elementary Science Library" and

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* Every teacher should send for this list.

gives a complete list of the best up to date references classified as follows: General Nature Study, Animal Life in General, Mammals, Birds, Fish, Amphibians, and Reptiles, Insects and other Invertebrates, Plant Life, Flowerless Plants, Flowering Plants, Gardening and Forestry, Earth and the Universe, Earth and the Stars, Earth and the Weather, Ancient Life, Physical Science, Bibliography.

List of films—

Ed. Science, 5 S. Wabash Ave., Chicago, Ill. The blue-book of non-theatrical films with brief comments on each title. Complete and revised annually. 75¢.

Books on Teaching Elementary Science—

Science In the Elementary Grades—W. C. Croxton, McGraw-Hill, publishers, 1937.

Science Guide for Elementary Grades—W. T. Skilling. California St., Dept. of Ed., Sacramento, Cal. 1934.

A Compiled List of Magazines—

A compiled list of magazines related to science in the Elementary Grades may be obtained from: David Russell, National College of Education, Evanston, Illinois. (May be had for the postage.)

Pamphlets on All Subjects—

American Educational Press, 40 S. Front St., Columbus, Ohio.

Magazine Articles Dealing with Elementary Science Equipment—

Daniels, S. L., Pupil Made Lantern Slides; Their Values and Uses, *Educational Screen*, XIII (September, 1935) 178–179; XIII (October, 1934) 205–207; XIII (November, 1934) 234–235.

Kuemmerleen, T. J., Science Experiments With 5 and 10 cent store Equipment, *Addresses and Proceedings*, N. E. A., LXII (1924), 903–908.

Neumer, Elsie F., The Science Room in the Elementary Schools, *Educational Method*, XVI (May, 1927), 432–434.

Persing, Ellis C., Science Library for Elementary Schools, *School Science and Mathematics*, XXXIV (May, 1936), 535–544.

Thompson, J. L., Science Laboratory for Grades 4, 5, and 6 in Cooperative Group Plan, *Educational Method*, X (November, 1930), 88–95.

Webb, H. A., Professional Magazines for Science Teachers, *Education* LVI (March, 1936), 445–446.

Noe, A. C., The Use of Charts in Nature Study, *Science* (new series) LXVII (June 8, 1929) 571–574.

Ramsey, G. F., Object-Specimen-Model Material That May Be Assembled Without Cost or at Very Little Cost in the Field of Elementary Science, *Addresses and Proceedings*, N. E. A., LXX (1932) 781–782.

Russell, David W., Fifty Educators Comment on Elementary Science, *Addresses and Proceedings*, N. E. A., LXXXVI (1938) 54–62.

Unpublished Thesis Including Research.

Material on Equipment—

Compton, Leila A., *Enriching the Teaching of Nature Study in Elementary Schools Through the Use of Free and Low Priced Materials*, Master's Thesis, Cornell University, Ithaca, N. Y. 1932.

Russell, David W., *Analysis of Opinions and Practices Concerning the Teaching of Science in the Elementary Grades*, Doctor's Thesis, Western Reserve University, Cleveland, Ohio. 1938.

Waldron, Margaret L., *Ability of Sixth Grade Children to Comprehend Science Material Written for the Grades*, Master's Thesis, University of Iowa, Iowa City, 1932.

MAGAZINES

Junior Natural History $1.00 per year. American Museum of Natural History. (Written especially for children.)

Nature Magazine $2.50 per year. American Nature Association, 1214 Sixteenth St., N. W. Washington, D. C. (Children enjoy it and there are many teaching aids for the teacher.)

Child Life. Rand McNally and Co., Chicago, Ill. $2.50 per year. (Stories of nature, adventure, and hygiene.)

Children's Activities. Child Training Association, S. Wabash Ave., Chicago, Ill. $2.50 per year. (Things to make and do. Some science and nature work.)

COURSES OF STUDY

Cleveland Public Schools. Elementary Science Course of Study. 1937. Price $1.00.

Course of Study for Science in the Grades, Board of Ed., New Rochelle, N. Y. 1935.

Science in the Elementary Schools. Grades 1–7. 1933. Maryland School Bulletin, State Dept. of Education.

Glenn Falls Public Schools, 1936. Price $1.00. Glenn Falls, N. Y. Science Syllabus, Vol. I. Elementary School Science Syllabus, Vol. II.

California State Department of Education Bulletin. Suggested course of study in science for elementary schools. 1932.

Science in the Intermediate Grades—Bertha Parker. University of Chicago Press. $1.25. Chicago, Ill.

Science Units. (grades 5–6). Shorewood Elementary Schools, Shorewood, Wisconsin.

A Guide for Teaching Science in grades 1–8. Department of Public Instruction, Des Moines, Iowa. 1937.

A list of outstanding courses of study can be secured from the curriculum journal. Published by the Society for Curriculum Study, George Peabody College, Nashville, Tennessee.

SCIENCE SERIES FOR ELEMENTARY GRADES

Science Stories and *Discovering Our World* (grades 1–6). Beauchamp, Melrose, Crampton, Gray, and Blough. Scott Foresman Co., Pub. 1935–38.

Elementary Science by Grades (Grades 1–6). Pershing and others. 1931. D. Appleton-Century Co., Pub.

The Nature Hour (4 book series)—Nicol, Levenson, Kahn. Silver Burdett, Pub. 1935.

Nature Series (Grades 3, 4, 5, 6)—Fisher, Clyde, Laughan. Noble and Noble, Pub. 1935.

World of Nature Series (Bks. I–IV)—Fisher and Laughan. Noble and Noble, Pub. 1935.

Pathways in Science (Bks. 1–6)—Craig. Ginn and Co., Pub. 1932.

The Scientific Living Series (Bks. 1–5)—Frasier, Dolman, and Van Noy. W. L. Singer Co., Pub. 1937.

Nature Activity Readers (Series 1–4)—Edwards & Sherman. Little, Brown and Co., Pub. 1933.

First Steps in Science (6 books)—McKay. Oxford U. Press, Pub. 1936. (Physical science series.)

Science Related to Life (Series of 4 books)—Reh. A. Book Co., Pub. 1932. (Sixth grade level.)

Early Journeys in Science (Grades 1–6)—Heising and Teethers. Lippincott, 1931 and 1938.

SOME MATHEMATICAL CONCEPTS TO BE TAUGHT IN THE TENTH GRADE OR TEACHING GEOMETRY AS A WAY OF THINKING

H. C. CHRISTOFFERSON
Miami University, Oxford, Ohio

[The following paper by Professor Christofferson is the first of a series of papers to be published during 1939 on the teaching of logic as applied to geometry and life situations and the function concept as a vitalizing principle in the teaching of mathematics.

We invite teachers of mathematics to submit papers presenting class room procedure relative to these two topics.

Chas. A. Stone
J. M. Kinney, *Math. Eds.*]

In searching for some striking analogy to emphasize the point of view of this study, I have been unable to improve upon the story of a boy who stammered and was sent to a school where he took formal exercises to remedy his speech defect. A friend met him after his return and remarked, "Hello, Bill, I understand that you don't stutter any more." Bill replied, "N-no, I d-d-don't stutter. I c-c-can say, 'Peter Piper picked a peck of pickled peppers', and 'She sells sea shells by the sea shore'; b-but it's so d-d-darn hard to w-work those ph-phrases into a c-c-conversation."

We read good literature and study correct speech in schools, yet pulp magazines are on the increase and "he don't" is still heard. We teach rules of health, and they are often ignored; we teach democracy and good citizenship, and there is still much snobbery, political graft, and selfishness. We discuss high ideals of character and there is still deceit, dishonesty, and immorality. We teach demonstrative geometry which is a course in perfect reasoning, yet there is much faulty and fallacious thinking.

The purpose of this paper is three-fold.

I To review some of the professed claims for geometry and geometry teaching.

II By analysis of a simple geometry exercise to point out the salient characteristics of the rigorous reasoning which geometry illustrates.

III To apply the same fundamental ideas about clear thinking and sound reasoning to a few typical non-geometric situations.

I. The Professed Values of Geometry

1. Among the functions ascribed to geometry by the National Committee on the Reorganization of Mathematics in 1923 is to "develop an understanding and appreciation of a deductive proof and the ability to use this method of reasoning where it is applicable, and to form habits of precise and succinct statement, of logical organization of ideas, and of logical memory."

2. Dr. Reeve claims in the *Fifth Yearbook* that "the purpose of geometry is to make clear to the pupil the meaning of demonstration, the meaning of mathematical precision, and the pleasure of discovering absolute truth. If demonstrative geometry is not taught in order to enable the pupil to have the satisfaction of proving something, to train him in deductive thinking, to give him the power to prove his own statements, then it is not worth teaching at all."

3. Professor Upton in the same yearbook contends that "Our great aim in the tenth year is to teach the nature of deductive proof and to furnish pupils with a model for all their life thinking."

4. Breslich claims "to reason correctly" as one objective of Geometry.

5. Schlauch asserts: "Geometry seems, of all school subjects the best adapted to initiate a student into the meaning of mathematics as a science of necessary conclusions."

6. The Joint Commission in its recent (1938) report on the Place of Mathematics in Secondary Education describes mathematics as a mode of thinking as follows.

"To *mathematize* a subject does not mean merely to introduce equations and formulas into it, but rather to mould and fuse it into a coherent whole, with its postulates and assumptions clearly recognized, its definitions faultlessly drawn, and its conclusions scrupulously exact. Mathematical methods set up an ideal, a norm, a pattern, which though not attainable in all the activities necessary and proper to man, serve as a relentless spur to improvement."

7. In a later chapter describing the work of the tenth grade, the Commission further claims that "there is a widespread demand that it be taught more successfully than in the past as exhibiting a mode of thinking that can be generalized or carried into situations not specifically mathematical . . . Above all else it is important so to plan and to teach that the pupil cannot fail to carry away from his study of demonstrative geometry not

only a clear understanding as to what is meant by a deductive science, but also some ability to apply the method of postulational thinking in life situations."

8. Even more helpful and precise is the claim expressed by Dr. Fawcett in the *13th Yearbook, the Nature of Proof*, "While teachers of mathematics say they want the young people in our secondary schools to understand the nature of proof, that should not be and probably is not their total concern. What these teachers really want is not only that these young people should understand the nature of proof, but that their way of life should show that they understand it. Of what value is it for a pupil to understand thoroughly what a proof means if it does not clarify his thinking and make him more "critical of new ideas presented"? The real value of this sort of training to any pupil is determined by its effect on his behavior, and we shall assume that if he clearly understands the nature of proof that his behavior will be marked by the following characteristics.

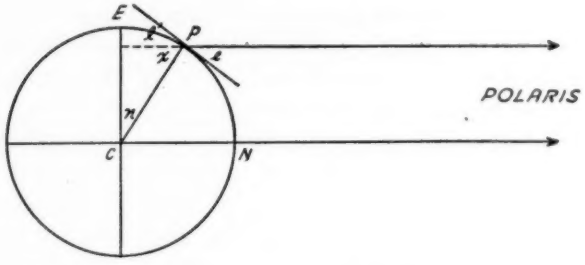
(1) "He will select the significant words and phrases in any statement that is important to him and ask that they be carefully defined.
(2) "He will require evidence in support of any conclusion he is pressed to accept.
(3) "He will analyze that evidence and distinguish fact from assumption.
(4) "He will recognize stated and unstated assumptions essential to the conclusion.
(5) "He will evaluate these assumptions, accepting some and rejecting others.
(6) "He will evaluate the argument, accepting or rejecting the conclusion.
(7) "He will constantly re-examine the assumptions which are behind his beliefs and which guide his actions."

Apparently we have plenty of authority for supporting the thesis that mathematics teachers should teach more than geometry in their geometry classes. Let us now examine geometry to attempt to point out what some of those extra values are and how they may be obtained.

II. The Nature of Geometric Proof

Just what are the elements of proof in geometry which we hope children will be able to apply or transfer? Suppose we take a geometric statement with which many of you are quite famil-

iar, but which is not too well known, and yet simple enough to illustrate the nature of geometric proof. We shall need to assume that rays of light from Polaris, as they reach the earth, are parallel. With this assumption it is evident that at the North Pole, Polaris would seem to an observer to be directly overhead and as one approaches the equator Polaris would seem to approach the horizon. One might even conclude that there may be some relationship between one's latitude north of the equator and the angle of elevation of Polaris. Let us then prove that the north latitude of a point in the northern hemisphere is equal to the elevation of Polaris, then we shall analyze this proof to discover its fundamental nature.



Given: The earth with center C, north pole N, equator E, and any point P.
Conclusion: l(arc EP) equals numerically angle e, the angle of elevation.

Proof:	1. angle e' = angle e	Vertical angles
	2. angle $e'+x=90°$	A tangent is perpendicular to a radius
	3. $n+x=90°$	The acute angles of a right triangle are complementary.
	4. .. angle n = angle e	Complements of angle x
	5. Arc EP equals numerically angle n	A central angle equals its arc
	6. .. l (arc EP) equals numerically angle e	Substitution

Analysis: The proof above depends for its rigor upon the following items.

1. Definitions: latitude, elevation, north pole, equator, horizon, and other mathematical terms, tangent, etc.
2. Axioms and postulates:
   a. Rays of light from Polaris are parallel.
   b. Polaris is directly above the north pole.
   c. The axis of the earth is perpendicular to the equator.
   d. Rays of light from Polaris are parallel to the earth's axis.
   e. A central angle equals its arc.
   f. Equals may be substituted for equals.

3. Previously proved statements.
   a. Vertical angles are equal.
   b. A tangent is perpendicular to a radius.
   c. The acute angles of a right triangle are complementary.
   d. Complements of the same angle are equal.

You will recognize that the truth of the conclusion $l = e$ (the north latitude of any point equals the angle of elevation of Polaris) is quite dependent upon (a) certain arbitrary definitions, (b) certain previously accepted statements called axioms, postulates, and theorems. The final conclusion is true only if these definitions and previously accepted statements are true. We shall now try to point out briefly just how these fundamentals of proof can be used outside of geometry.

III. Applications of Geometric Proof in Non-Geometric Situations

1. Dr. Fawcett describes his first day in a geometry class, beginning as follows. "There is no great hurry about beginning our regular work in geometry and since the problem of awards is one which is soon to be considered by the entire school body I suggest that we give some preliminary consideration to the proposition that 'awards should be granted for outstanding achievement in the school'."

He describes the results. "While it developed that within this particular group there were not many pupils who openly opposed the granting of awards, the opposition that was offered was thoughtful and intelligent. Within a very few moments after the discussion started the question was raised as to whether a teacher's salary was an award. One pupil argued that everybody worked for an award of some kind. Another asked whether playing on the football team constituted an 'outstanding achievement' while another believed that grades on academic achievement were awards. Vigorous disagreement developed, even among those who were supporting the general proposition that awards should be granted, and considerable time was spent in what might appear to have been useless discussion. However, when the teacher summarized the discussion, pointing out the differences that had developed and clarifying the real issues which had arisen one pupil said, "Most of this trouble is caused by the fact that we don't know what we

mean by 'awards' or by 'outstanding achievement' "; and the evident agreement with this statement by other members of the class indicated that, although the word 'definition' was not used, many of the pupils recognized in this situation the need for clearly defining these two ideas. The school body later decided to grant awards under certain conditions and one of the conditions was that the pupil receiving the award 'must be a good citizen.' In discussing this, one of the pupils promptly pointed out that before this award plan could be effectively administered "someone will have to explain what is meant by 'good citizen'."

2. Perhaps you will excuse a reference to my own high school class. Last month I tried on my geometry class one of Fawcett's sentences, "Lincoln spent very little time in school." Almost at once one boy remarked that the truth of the statement depended entirely upon what was meant by school. Soon another called attention to the fact that the situation was like the one about a straight line cutting a circle in only two points, which was true only when we defined circle as a line.

Next was submitted the statement, "George (one of my best) is a mean student" and we asked what that meant. Soon the various meanings of the word mean began to come out. One boy said, "When we say a man is a mean shot with a gun, we mean that he is good." Soon we had "mean" to mean cross, average, good, humble, with little money, hard-boiled.

Several statements were submitted in which meaning was quite dependent upon crucial words, upon the setting, and even upon the tone of voice in saying it.

(1) "Cut-it-out."
(2) "He can give it and he can take it."
(3) "Babbling brooks are shallow." This has many possible meanings.
(4) "When O. Henry came to New York he made very little money, yet he was a great success." One thought O. Henry a candy maker. Then, too, success had to be defined.
(5) Dizzy Dean made an error.
(6) The Yanks won the world series, or the Yanks won the World War.

These are typical of many statements given whose meanings depended upon definitions of words used. It is evident that the number is unlimited.

Next we looked for a statement to be proved. The following was proposed. (This occurred in October.)

"The Sudeten should be ceded to Germany." The grounds for the Munich decision were then analyzed. They were as follows:

(1) The Sudeten is mostly German.
(2) Germany should govern all German people, especially when not separated from Germany by some natural boundary such as an ocean.
(3) The Sudetens want to join Germany.
(4) Peace must be maintained.

The geometry assignment for the next day was, first to bring in some statement which would not be accepted at once by everyone but would need proof. Then to study the proof for it and the ideas upon which the proof depends. Second, to try proving the statement, "England should cede Canada to the United States."

The next day the relation between the grounds for ceding Sudeten to Germany which England had accepted and the Canada statement were pointed out. Furthermore they soon realized that these grounds for action in international affairs are like postulates or theorems in geometry. They were accepted without argument apparently in some cases, and after considerable discussion in other cases. Yet it is evident that the rigor of the reasoning depended on them.

Other statements needing proof which were brought in included the following:

(1) There is no room for black shirts in a democracy.
(2) A war can be won by war planes alone.
(3) Czechoslovakia should pay reparations to German.
(4) Bombers are hard to defeat.
(5) The New Deal Economy is a failure.

A very interesting situation arose in connection with New Deal Economy. The only meaning several students had for economy was thrift or saving, being economical, and the New Deal was not very saving. The postulates or theorems upon which the statement depended included ideas on re-distribution of wealth, relief and employment through public works rather than dole, etc.

In connection with the "black shirts" statement, the difference in the fundamental principles underlying the various governments was soon brought out. The blind obedience and

disregard for personal rights represented by black shirts was quite contrary to the doctrines of democracy. These doctrines being so fundamental are like postulates in geometry. "We hold these truths to be self-evident, that all men are created equal, etc." from the Declaration of Independence, in fact the Constitution itself, is our system of postulates of government. Political party platforms constitute the basis for party action and give the differences between parties. These also are of the nature of fundamental postulates supposed to control party actions.

3. In a popular magazine is to be found the following statement by the United Brewers Industrial Foundation in an advertisement with the large caption, "Which road America?" This heading was over a picture of a road with three branches, one to the left leading to the "dead end of excess," to the right was the "stony harsh road of intolerance," and one straight ahead seemed a comfortable, beautiful, broad highway of moderation and sobriety. Framed under the picture was the following statement. "Beer is one of the oldest and best of beverages; its use is widespread in every land; it is within the reach of every purse. . . . The growth of its use in this country is bound to make for general temperance; for there is nothing more promising to combat the evil of too much alcohol than the opportunity of drinking good beer."

The above statement could be formulated into the form of a geometry theorem as follows, "If we provide the opportunity for drinking good beer, we will successfully combat the evil of too much alcohol." It is apparent that such phrases as "successfully combat" and "provide the opportunity" need to be clearly defined before we know what the statement really means. In addition to that its acceptance will be wholly based upon other statements which would be in the nature of postulates or previously proved theorems. Such statements as the above make us appreciate the truth of Dr. Fawcett's statement that in geometry "the student's native ability to think is not stifled by prejudice or bias. He becomes conscious of the fact that his conclusions are determined by the definitions and assumptions which, he, himself, makes and he recognizes the far-reaching effect of these basic ideas."

4. Other typical non-geometric statements needing proof might include such statements as the following.

(1) If the temperature drops below 72° in the living room, the thermostat will automatically open the drafts of the furnace and supply more heat.
(2) If the drafts of a furnace are controlled, the temperature of the living room will be controlled.
(3) If you wish to control the temperature of your living room, you must supply fuel as well as control drafts in the furnace. Therefore, to do both, buy a stoker.
(4) A salesman came to our door the other day. His opening contact was, "We are making a survey of this community and would like to know how long you have lived here". Mrs. Christofferson answered, "ten years," and let him in; he seemed such a fine looking young man, possibly a college student. His reply, "Then you are entitled to one of our free samples to beautify your home." He proceeded to open up a conveniently constructed brief case containing tinted photographs enlarged. Mrs. Christofferson at once queried in a frigid tone, "Are you selling this stuff?" He countered, "Oh no, not today. I would not let you give me an order if you wanted to. I will let you pick out a free sample to beautify your home and later, if you wish me to, I'll return for an order." There were no fatalities as he was assured that we did not wish his samples.

What was the reasoning which he did? Apparently his sales technique had two steps: (1) If I can pretend I'm making a survey, I'll get into the house and size up the family. (2) If they accept a free sample, done in quantity and not too expensive, then I may get an order later. Clearly this sales technique which depended on these two propositions worked, because in a confidential talk with the lad he said he had been making good money. While these theorems of selling had been demonstrated by experience and intuition, and probably were never proved formally like a geometry theorem, yet it is evident that there is logic back of them.

5. Converses and their close friend indirect proof form a problem which alone merit the attention of a paper at a Central Association meeting. They are rather inadequately treated in most geometries. Converses are usually not true, yet few if any are mentioned in geometry texts except those that are true. All right angles are equal, yet not all equal angles are right angles. One of the most common fallacies in thinking is to assume the

converse true, usually more or less unconsciously. This is particularly true in advertising.

An advertiser pictures a movie star or other beautiful girls with handsome men smoking X cigarettes. He wants the reader more or less unconsciously to assume the following theorem and its converse. "This charming movie queen and her friends smoke X cigaretts, so if I am as charming, I too should smoke X cigaretts," and conversely, "If I smoke X cigaretts, then I will be as charming as this movie star or as these young people." The same conclusions can be shown to be in the background for many advertisements, namely: a 1939 automobile, a Christmas ocean cruise, new plumbing fixtures for your bathroom, new winter hats and garments for the ladies, and for men.

It has been the purpose of this paper to emphasize some concepts in geometry which apply widely to non-geometric situations. Geometry being so concrete and "free of prejudice and bias" serves admirably as a pattern for thinking. It demonstrates the need for clearly defined terms, and also that the truth of any statement usually depends upon other more basic statements called postulates or upon other related statements called theorems which have been previously accepted.

Outside of the field of geometry when we draw conclusions based upon certain conditions, it is apparent that we still need definitions and that the conclusion still depends upon previously accepted and related statements. The relationships are not so simple nor so concrete, the conclusions are not so easily demonstrated nor so rigorously. Yet it is evident that geometry could be a more vital force in modern education if the teacher pointed out these and other essentials of proof for conclusions and at least occasionally made application of them to thinking in non-geometric situations.

URGES NAMING PALOMAR OBSERVATORY AFTER DR. HALE

Naming the California Institute of Technology observatory on Palomar Mountain, site of the 200-inch telescope, in honor of the late Dr. George Ellery Hale, world renowned astronomer, is being considered seriously.

Dr. Hale's name will form the permanent name for the observatory, hopes Captain Clyde S. McDowell, supervising engineer, who held it only just that the man who envisioned the giant project be so honored.

Captain McDowell said that no formal action as to the selection of a name has been taken, however.

At the time of his death Dr. Hale was in charge of the observatory enterprise, and wrote the magazine article which resulted in the project's endowment.

THE WISDOM OF TRYING TO TEACH THE BRÖNSTED NOMENCLATURE

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The teacher of science is frequently confronted with serious problems in the selection of material for his subject. Theories change and almost constantly he is beset with conflicting influences. "Shall I teach these new viewpoints before they are universally accepted, knowing that they may be discredited at any time, or shall I be conservative and present the older views, thereby running the risk of being considered a trifle behind the times?"

The teacher of chemistry is particularly likely to find himself facing such a dilemma, because chemistry is a science which has developed rapidly and changing viewpoints are almost a chronic condition. Sometimes these new theories are not particularly troublesome because they deal with some situations which are of minor significance. But at times there are fundamental changes in basic theories and then the dilemma becomes more serious. We now face a problem of no small importance when we come to the theory of ionization and the accompanying topics of acids, bases, and salts. Shall we use the nomenclature and language of the familiar Arrhenius theory or shall we discard this long-established viewpoint and express all these relations in terms of the Brönsted theory?

It does not seem logical to expect chemistry teachers in secondary schools to determine when a change should be made especially with respect to fundamental theories. As a rule they are not in a position to determine the trends in chemical thought or to sense the strategic opportunities for change. A conservative attitude toward these changes seems to be the proper one to assume. Certainly it would be difficult to inaugurate any deep-seated innovation either in college or in high school teaching until suitable textbooks are available. These usually appear first in the field of college teaching, but they are generally followed rather promptly by similar texts for use in high school classes. It appears likely that the pupil of average ability will succeed much better in as intricate a course as chemistry if his teacher adheres rather closely to the order and method of presentation followed in the textbook, than he will if too extensive

deviations are made. Therefore, it seems to me, a safe rule to follow is to adopt a modern textbook and to abide by its plan of development and to use its language and viewpoint.

This attitude might lead to an ultraconservative situation unless the teacher is alert to the trends in chemical thought. Certainly the familiar couplet,

> "Be not the first by whom the new is tried
> Nor yet the last to lay the old aside."

is an excellent adage for us to follow. We must not be too eager to use new expressions and none of us wish to be regarded as old fogies. Some middle ground is the sensible position. We must be ready to keep up with the growth of chemistry while at the same time we should be certain which way the procession is moving. This attitude requires us to know new chemical theories and to be prepared for their use whenever such a step seems advisable.

The nomenclature of the Arrhenius theory is essentially that of water solutions. The rapid advances made in the use of non-aqueous solvents have made necessary some adjustments which have led to confusion. As a result there seems to be a growing feeling that the theories connected with solutions should be taught by the Brönsted system of nomenclature, since this may be applied alike to aqueous or non-aqueous solutions. Some opposition has been shown to such a change on the ground that the Brönsted theory is too difficult for beginners. Our experience with freshman classes in the University has led us to believe that the Brönsted theory is little or no more difficult *for a beginner* than is the older theory. The former *seems* more difficult to a person who has been trained in the latter, because he must unlearn one system before he can learn a new one. To the beginner either system is difficult and there seems to be little difference in the effort required for its mastery. The advantage in offering the Brönsted theory comes from its more general application.

Let us compare some of the fundamental expressions of the two theories in order to see how closely they compare.

According to Arrhenius an acid yields hydrogen ions. Since the hydrogen ion is a single proton we may define an acid as a substance which yields protons—a proton donor. Using HCl as a typical acid this process is represented in familiar fashion:

$$HCl \rightleftarrows H^+ + Cl^-.$$

Since the proton is known to be associated with one or more

molecules of the solvent, it is customary according to Brönsted to show that the proton is promptly hydrated by a reaction which involves the solvent:

$$H^+ + H_2O \rightleftarrows H_3O^+ \text{ (or } H^+ \cdot H_2O).$$

These two steps may be combined in a single expression

$$HCl + H_2O \rightleftarrows H_3O^+ \text{ (or } H^+ \cdot H_2O) + Cl^-.$$

The name "hydronium ion" is sometimes applied to this hydrated ion in order that it may be distinguished from hydrogen ion H^+. Thus it is seen that these two theories are quite similar in so far as acids are concerned.

Turning now to the language used with respect to bases, we find that the Brönsted theory used a broader concept than that to which we are accustomed when we employ the older theory. Since bases are always considered the opposite of acids and if we use "proton donor" as a definition for an acid, then the behavior of a base may be that of a "proton acceptor." In the above ionization equation Cl^- combines with the proton to form HCl, hence Cl^- is a base sometimes called a "conjugate base." Since the water molecule accepts H^+ it is also a base. So we have two bases Cl^- and H_2O in competition for the H^+. If water is a stronger base than Cl^- then the equilibrium will shift to the right and HCl is known as a strong acid because it yields many protons. But in the case of acetic acid

$$HC_2H_3O_2 + H_2O \rightleftarrows H_3O^+ + C_2H_3O_2^-$$

the conjugate base ($C_2H_3O_2^-$) has a strong affinity for the proton and as a result the equilibrium shifts to the left making acetic acid a weak acid. In the old theory the strength of an acid is determined by its own ability to break up, yielding hydrogen ions; in the new theory emphasis is placed upon the behavior of the conjugate base derived from the acid.

In these ionization equations we have two acids (in the first equation, HCl and H_3O^+) since both are ready to act as proton donors. In like manner we have two bases (H_2O and Cl^-) since both may act as proton acceptors. Hence we may write the general formula for the ionization of an acid in water solution

$$A_1 + B_2 \rightleftarrows A_2 + B_1.$$

The two bases are in competition for the proton. If B_1 is successful in the competition and combines with most of the protons,

then A_1 is a weak acid because it is slightly ionized. If B_1 is a weak base (like Cl^-) then the water molecules are successful in capturing most of the protons and there results many H_3O^+ making A_1 a strong acid.

In the new theory anything which combines readily with the proton is a base. Accordingly the hydroxyl ion is a base which differs from the conjugate base derived from an acid only in the intensity of its action toward the proton. In the case of the hydroxyl ion there is a very strong tendency to combine with the proton, hence OH^- is the strongest base that we have, since it is our strongest proton acceptor.

In the preceding study the water molecule acts as a base, because it accepts protons forming H_3O^+. Water may also serve as a proton donor as for example.

$$\underset{\text{B}}{NH_3} + \underset{\text{A}}{H_2O} \rightleftarrows \underset{\text{A}}{NH_4^+} + \underset{\text{B}}{OH^-}$$

In this case OH^-, a strong base, is successful in combining with most of the protons supplied by NH_4^+ and as a result H_2O is a very weak acid. Consequently water is both an acid and a base, but it is relatively weak in either capacity. Its dual behavior may be expressed

$$H_2O + H_2O \rightleftarrows H_3O^+ + OH^-.$$

If some solvent other than water is used similar behaviors are encountered. Thus, if an amine is used as a solvent for HCl its ionization would be expressed

$$\underset{\text{B}}{RNH_2} + \underset{\text{A}}{HCl} \rightleftarrows \underset{\text{A}}{RNH_2 \cdot H^+} + \underset{\text{B}}{Cl^-}$$

The strength of HCl as an acid in an amine as a solvent will depend on the competition between Cl^- and RNH_2 for the proton. If Cl^- wins then HCl in such a solvent is a weak acid; but if the amine wins then the solvated hydrogen ions predominate and HCl is considered a strong acid.

Thus it is seen that in the Brönsted theory of acids and bases attention is centered in the competitive strength of the base while in the Arrhenius theory we speak of the power of ionization of the acid. Under the new phraseology HCN and H_2CO_3 are weak acids because CN^- and CO_3^{--} are strong bases and combine with most of the protons. Likewise H_2SO_4 and HNO_3

are strong acids because SO_4^{--} and NO_3^- are weak conjugate bases and, therefore, unsuccessful in the competition for protons.

The language of the Brönsted theory may be employed in a great variety of situations but we will limit our consideration to two cases, hydrolysis and hydrate formation.

If $SbCl_3$ is added to water a precipitate of SbOCl is formed and the solution is strongly acid. There are two reactions taking place

(1) $$SbCl_3 + H_2O \rightleftarrows SbOCl\downarrow + 2HCl$$

(2) $$HCl + H_2O \rightleftarrows H_3O^+ + Cl^-.$$

In (1) molecules of HCl are formed but since they are promptly used up in (2) the precipitate SbOCl persists. If we add to such a mixture any excess of HCl the number of H_3O^+ is greatly increased, so (2) is reversed and this in turn reverses (1) until the precipitate disappears. This is an example of reversible hydrolysis in which an insoluble salt is produced, giving visible evidence of the chemical interaction between solvent and solute.

When the hydrolysis is partial and produces no insoluble form, the reaction of the solution toward indicators is sufficient evidence for believing that hydrolysis has taken place. If anhydrous copper sulfate is dissolved in water much heat is evolved, indicating a chemical reaction between solute and solvent. It it likely that this reaction is between water and the metallic ion since positive ions are generally solvated. We can think of the hydrated copper ions as consisting of a positive kernel with four molecules of water arranged symmetrically about it. Each of these molecules of water is linked to the positive ion by a coordinate covalence, that is by a pair of electrons donated by the oxygen of water:

$$\left[\begin{array}{c} H_2 \\ O \\ \cdot\cdot \\ H_2O:Cu:OH_2 \\ \cdot\cdot \\ O \\ H_2 \end{array}\right]^{++}$$

The covalent bond between copper and oxygen is weak and the pull of the positive metallic ion upsets the electrical balance in the water molecules. As a result there is a tendency for H^+ to become labile. Now the conjugate base which is present in

solution (SO_4^{--} from the copper sulfate) is weak and as a result the relatively strong base, water, collects protons forming H_3O^+. There is also formed such an ion as $[Cu(OH)\cdot(H_2O)_3]^+$ This reasoning accounts for the acid reaction of such solutions as those of $CuSO_4$, $FeCl_3$, and $AlCl_3$. It also accounts for the familiar behavior of solutions of $MgCl_2$, which upon evaporation yield MgO because of the gradual removal of protons from the hydrated magnesium ion.

On the other hand when such salts as sodium acetate, potassium cyanide or sodium carbonate are dissolved in water, their solutions are markedly alkaline. This may be explained in a similar manner. The cation (e.g., Na^+) is hydrated, the water molecules being held by weak coordinate covalence bonds. The strongly positive cation upsets the electrical symmetry of the water molecules causing H^+ to become labile. In these cases the conjugate bases present in these salts are strong bases and as a result they combine with many protons. These protons are removed either from the hydrated cations or from the solvent in the usual water equilibrium ($H_2O \rightleftarrows H^+ + OH^-$). There remains in solution an excess of negative ions,* mainly OH^-, and this accounts for the alkaline reaction of such solutions.

The formation of hydrated metallic ions may be used to explain the formation of crystals which retain a part of the solvent, giving the substances commonly known as hydrates. As a water solution of copper sulfate is evaporated, the hydrated metallic ions containing 4 molecules of water are paired off with the hydrated sulfate ions ($[SO_4\cdot H_2O]^{--}$) in their regular crystalline space lattice. The resulting crystals are neither deliquescent nor efflorescent, since their tendency to liberate molecules of water is just balanced by the vapor pressure of the atmosphere at usual humidity ranges. But when $CuSO_4\cdot 5H_2O$ is heated it loses four molecules of water readily. These are undoubtedly the molecules surrounding the metallic ion. The fifth molecule of water is held securely until a higher temperature is reached, at which point the salt becomes anhydrous. This reasoning explains the well-known behavior of blue vitriol when it is subjected to the influence of higher temperatures.

It is doubtful whether these new viewpoints should be taught extensively in secondary schools at the present time, because undoubtedly the big majority of pupils will still encounter the

* We may postulate the formation of such hydrated ions as $[H_2O{:}Na{:}OH_2]^+$ which upon loss of two protons would yield the ion $[HO{:}Na{:}OH]^-$, which would be equivalent to $Na^+ + 2OH^-$.

Arrhenius theory in their later contacts with college chemistry. But progressive chemistry teachers everywhere will want to be thinking in the language of the new theories, because the advent of non-aqueous solvents as important factors in our commercial practices has made necessary a broader interpretation of the terms, acid and base. The use of the Brönsted terminology has the advantages of adapting itself alike to the chemistry of water solution or to solutions in other solvents. It also explains some well-known facts which are not adequately accounted for in the Arrhenius theory. So it is to be hoped that we will use the new viewpoints whenever they contribute to effective teaching and hold ourselves ready to employ these concepts when the trend in chemical education seems to indicate that the time is ripe for such a step.

AMERICAN ASSOCIATION OF JUNIOR COLLEGES

Three days, instead of two as in past years, will be devoted to the annual meeting of the American Association of Junior Colleges which will be held at Grand Rapids, Michigan, March 2–4, 1939. One session will be devoted entirely to a consideration of semi-professional courses in the junior college; another to future junior college policies, with twelve past presidents of the Association participating; a third to problems peculiar to the publicly controlled junior colleges; and a fourth to those characteristics of the privately controlled institutions.

All junior colleges in Michigan will close so that their staff members may attend the meeting. The Association has recently been reorganized, and national headquarters established at Washington, in charge of the new Executive Secretary, Dr. Walter Crosby Eells, formerly professor of education at Stanford University. More than 500 junior colleges, with an enrollment in excess of 150,000 students, are found in the United States.

PRUNES FOR BOSSY

Prunes, butt of vaudeville jokes in days when there still was vaudeville but now seriously recognized as a valuable part of human diet, may presently take their place as stock feed as well. In experiments at the animal husbandry division of the University of California, it was found that ground prunes mixed with hay are relished by livestock and that they added a number of desirable compounds to the animals' diet.

ARGENTINE CONSERVATION

Wildlife protection in Argentina, long neglected, is now being taken up energetically by the various states of the republic. Conservation measures apply not only to animal and plant life but to striking elements of the environment as well. For example, in certain mountainous areas quarrying has been stopped, and highway development threatening the wooded banks of the Plata River is being reconsidered.

MAKING LABORATORY WORK IN PHYSICS FUNCTIONAL

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Desirable as it might or might not be, the reorganization of the science program and course offerings in the secondary schools is not the immediate problem of most of us who are teaching physics. Perhaps some of us are thinking about the need for such reorganization or even attempting to do something about it, but right now we are concerned with the problems of teaching the young folks in the physics classes now set up. And in some of our schools there are likely to be similar physics classes for some time. What can we do to make such courses more functional and valuable for these boys and girls?

Ever since physics was introduced into the secondary school years ago as "natural philosophy," teachers have made more or less use of the great variety of different techniques and activities which are fortunately available in this area. Reading in texts, references and magazines, working problems, reciting, observing demonstrations, working in the laboratory, studying charts, using work books and laboratory manuals, making use of bulletin board material, slides, movies and other visual aids, working on individual problems, participating in discussions, going on field trips—these are some of the pupil experiences which have and can be utilized in physics teaching. Why do we use these? How do we know when to use them, and whether they are functional and effective?

Such experiences or techniques are, or should be, simply means to certain ends—they are the ways, the activities which will enable pupils to make progress toward the achievement of desired outcomes. What these desired outcomes are, what the changes in pupil behavior, or the objectives of your course in physics, is largely up to you in consideration of your particular total situation. These may be, and probably should be, considerably different from the outcomes sought for by another teacher of physcis in some different situation. We have given a great deal of time and attention to the discussion of objectives or purposes. Perhaps we need to give some attention to how these may be achieved.

Most outcomes are not achieved automatically just by mere performance or "going through the motions." Too often we lose

sight of the objectives, the purposes, the outcomes, and see only the performance, only the technique or experience. The means too frequently becomes the end itself. Motion pictures for instance, are not necessarily "good" in themselves. They may, however, be excellent aids in achieving certain outcomes. But just to use them in the physics class every Friday, regardless of the relation between the available film and the unit or material studied, or of their pertinence to desired outcome, is obviously not "functional."

Since we cannot discuss all of the variety of techniques or experiences possible of use in physics classes, let us consider one of these,—the use of the laboratory. How can it be made functional?

Prestige of the Laboratory

The laboratory has a sanction and prestige of years of successful operation in colleges and universities and research institutions. The results which have been achieved by means of the laboratory in advancing the frontier of scientific knowledge and in making application of such scientific information to a great variety of industrial and engineering uses is well known. Ours is a laboratory age. So well thought of is the laboratory even in educational circles that we have, or advocate, social studies laboratories, mathematics laboratories, industrial arts laboratories, fine arts laboratories. Just to have a laboratory, or to even call something a laboratory, is almost sufficient to give it educational sanction.

Two factors particularly have contributed to the great esteem with which the laboratory has been surrounded. One of these is its relation to "scientific method," which is usually assumed to be the method of the laboratory. The other is the educational doctrine of "pupil activity." The laboratory is advocated as *the* method, because it provides pupil activities and fosters scientific method—could any other justification be needed?

What's the Matter with Laboratory Work?

But laboratory work has not always been as functional and effective as we would like to have it. Thoughtful teachers of physics have for a long time been concerned with the inadequacy of the laboratory work in physics classes. To be sure, it is pupil activity— it is an excellent way to keep pupils busy, to keep them from doing some other things which might otherwise be annoying to teacher and of questionable value to pupils. In

spite of its vaunted merits, pupils not only do not seem to make a great deal of progress in using the "scientific attitude," but do not even seem to get the information, concepts, and applications which have been set as goals. In fact the evidence seems to indicate that achievement in understanding and applying the usual facts and principles of physics can be attained as well by the use of demonstrations or other techniques as by individual pupil laboratory experiences.

And we continue to assume, apparently, that two or three laboratory periods per week, with each pupil "going through" the same experiment at the same time, is meeting the needs of the wide range of individual differences in the pupils of even the rather selected group in a present day physics course. That the performance is often perfunctory for pupils is recognized by most teachers. Pupils too often follow directions blindly; their only purpose is to get it done and turn in results which will be satisfactory to teacher. That the procedure is a long way from scientific method is painfully evident in many cases. Often even unscientific methods are fostered by the emphasis upon results which must come up to teacher's expectations. Conclusions are too frequently based upon insufficient data, generalizations are "jumped at" from single instances, results are "juggled," relevant factors are uncontrolled, unwarranted conditions are assumed, or the assumed factors are not made evident, data are misinterpreted. This is pupil activity, certainly—but it is not the type of experience which encourages scientific method or reflective thinking—in fact in too many cases thinking is entirely out of the picture.

Another ineffective phase of laboratory work is the usual notebook write-up. One may well raise the question as to whether the writing-up of formal notebooks by pupils and the correcting of these by teachers is worth the time of either, in consideration of the results obtained.

Why Have Laboratory Work?

Part, at least, of the answer to these difficulties concerning the non-functioning of laboratory work lies in a consideration of the reasons for using it. Why have laboratory work? The purpose of laboratory work in physics, like that for using demonstrations, visual aids, directed study or any other pupil experience is that it gives promise of making progress toward desired outcomes. The laboratory activity itself is not or should

not be the end—it is a means to an end. Merely doing laboratory work on Tuesday and Thursday does not insure that the desired outcomes will automatically be achieved. It should also be recognized that laboratory experiences may be uniquely appropriate for some outcomes, but quite irrelevant for others. If laboratory activities give promise of furthering certain desired pupil outcomes, they should of course be used—used in such a manner that progress toward these outcomes is really made. If, on the other hand, laboratory experiences do not give promise of furthering certain desired outcomes in the light of the content, past pupil experiences, nature of the outcomes, pupil interests, and other factors, then laboratory work should as certainly not be used. Some other activity which does give promise of achieving the desired outcome should then be made use of—whether it is laboratory day or not.

Suggestions for Making Laboratory Work Functional

One of the first questions which needs to be raised about any given "experiment" or laboratory activity is concerned with the outcomes which may accrue from its "performance" by pupils. Is it the kind of activity which will best aid in achieving a certain outcome or a number of outcomes? What are the outcomes toward which it is desired to make progress by means of this experiment? Too often pupils are "put through" experiments without any goal in their minds or the minds of the teachers—except the vague one of "learning" some physics, or the vaguer one of "learning the scientific method." The teacher, and perhaps in some cases the pupil, needs to have in mind the outcomes, which are to be furthered by a particular experiment. One is often embarrassed to answer the pupils' frequent query, "What's the use of this experiment? Why do we have to do it?"

Clarity of Purpose and Procedure

Most so-called experiments in a text or manual have some such heading as the "problem" or "purpose." Often when pupils are asked, while they are performing an experiment, what they are doing, or what they are trying to find out, they cannot tell but have to look up the statement in the manual. The laboratory is a place to find answers to problems. Unless one knows what it is to which he is trying to find an answer—unless he has a problem—the "answer" is quite likely to be meaningless. Even if "Experiment No. 27" is to be assigned to pupils, it will

help them to get a great deal more out of their "performance" of this experiment if they know just what it is they are trying to do. It is little wonder that pupils get small value out of their laboratory "experimentation" when they are assigned such problems as to determine the specific heat of certain metals, the heat of vaporization, the resistance by means of the Wheat stone Bridge, or to "prove" Boyle's law, when they do not know what are the meanings of the terms, have no idea of the reason for or pertinence of the problem, and are confused by the principles and applications involved.

Closely linked with a clear understanding of the purpose of a problem is the method of procedure. Here is the problem to which we are trying to find an answer; how will we go about it? Why shouldn't pupils have a part in determining procedures, or at least knowing why certain things are performed as they are? Of course it would depend again upon the outcomes desired. If the outcome one has for pupils is to be able to follow directions, then experience in following directions would seem to be pertinent. But if the outcomes are concerned with understanding certain principles or concepts, or with the application of these, or with particular aspects of problem solving (scientific method) then the "activity" of following directions might not be so appropriate. One may well question whether pupils learn how to think or to be "scientific" as a result of their experiences in the usual high school science laboratory, where others set up the problems to be solved and direct their movements, even to the details of how the results are to be recorded.

While the continued use and reliance upon the following of directions in a laboratory manual may have some value for certain purposes, it too often proves to be a crutch that provides experiences and tends to develop habits and attitudes which are almost directly opposed to those concerned with the outcomes toward which we profess to be striving.

Of course less "ground" and a smaller number of "experiments" will probably be covered if emphasis is placed upon the working out or the understanding of methods of attack or procedures by pupils. But at least the ones which are "covered" have a better chance of being meaningful and providing worthwhile experiences for pupils. Pupils cannot well consider possible ways of attacking a problem, or the appropriateness or reasons for suggested procedures, without knowing what is the purpose of the problem or "experiment."

A Modified Laboratory Plan

In view of these and other considerations a plan of pupil laboratory work is suggested which has been made use of over a number of years in a variety of modified ways by different physics teachers to meet the needs of their particular situations and their own ways of teaching. The plan embodies these features:

(a) Laboratory work when and as needed.
(b) Pupil participation in laboratory procedure.
(c) No laboratory manual or formal write-up.
(d) Use of a laboratory quiz.

Laboratory Experiences when Needed

The too-common plan of having laboratory work on two or three fixed days each week, often unrelated to the discussions, reading, demonstrations, "exercises," tests, "recitations," or "lectures" of the other periods, hardly makes it possible for laboratory experiences to function satisfactorily or effectively. After all, the class periods are for the use of pupils, that they may have the experiences which will be valuable in achieving certain purposes. If study, or movies, or individual projects, seem more appropriate for achieving the desired outcomes, why should not the double-period be used for one or more of these experiences? There would then be laboratory experiences when and as the need for them arose.

Pupil Participation in Developing Laboratory Procedures

When a problem arose, or when teacher or pupils felt the need for utilizing such experiences, the laboratory would be used. Everyone would know the nature of the problem. It could be stated in different ways—in pupil language—or one particular statement of the purpose might be agreed upon by the class. In this particular plan no laboratory manual would be used. Pupils would agree upon what they were after in the laboratory "experiment" and develop together a plan or procedure for "solving" it. This development of the procedure might take some little time—part or all of a 40 or 50 minute period; but pupils would have an idea of what they were doing and why they were doing it, when in the laboratory. Of course teacher would need to guide the discussion, make suggestions, and be

arbiter in the case of disputes. It might be desirable in many cases to allow some pupils to try out different procedures for the same problem. All of the members in the class, who are going to "perform" the experiment, should, of course, participate in this planning of procedures. Perhaps one of the pupils could jot down on the blackboard notes as to what the class agrees upon for the method of doing the experiment. These would not be detailed directions which everyone would copy, but guides to whatever notes each pupil might want or need to take.

It might be desirable for the development of this laboratory procedure to make use of the single period on the day preceding the double period on which the laboratory work was to take place. This would be true especially if the experiment were quite long or somewhat complicated. In this case it would be desirable that most pupils take some notes. At the beginning of the laboratory period the next day, a brief review of the problem and proposed method of attack could be made by pupils.

Use of Laboratory Questions

To call attention to important ideas, concepts, applications, results, or implications of the experiment, the teacher may wish to include a few questions which pupils are to answer. It is usually well to ask that the answers to these be turned in at the end of the laboratory period, or at the beginning of the next class period. This tends to allow pupils to make use of the experiments for finding the answers to the question, and is one way for providing for the differences in the time of finishing by different pupils. Those who finish up their experiments, might use the remainder of the laboratory period in reading about and in writing out their answers to these questions. The questions should be "thought type" questions, in general, rather than those which can be answered by a single word or phrase copied from a book.

Laboratory Quiz

Instead of having pupils turn in a formal write-up, with the usual object, apparatus, procedure, results, and conclusion included, in this plan, an evaluation of pupils' progress is made by means of a laboratory quiz. The formal write-up of each experiment usually means considerable work and time for both pupil and teacher, and is of questionable value. It not only fails to provide the teacher with a good indication of what pupils have

got out of their laboratory experience, but it is often perfunctorily and even dishonestly written up by the pupil.

The laboratory quiz may consist of objective type questions, such as completion, or matching items, or of essay type questions, or a combination of both. One purpose might be to determine if pupils did understand what they were doing, or the meaning, and significance of the results. Another might be to determine if they could apply the results of their laboratory experience to another situation. Another purpose might be to indicate what progress pupils were making in the use of certain phases of scientific method—such as interpreting the data from experiments or drawing valid conclusions. The items of the quiz would have to be carefully prepared in the light of the purposes of the quiz. A test upon subject matter might give little evidence of other important outcomes for which the laboratory experience had been planned. This quiz should be discussed with pupils "immediately after taking" while it is still "hot," and pupils are interested in the facts, applications, and thinking involved.

Conclusion

It should be emphasized that no plan, or scheme or technique runs itself. This is particularly true if the plan is different in its procedure from the type of experience with which both teacher and pupils have been working for some time. The regularity and definiteness of the usual twice-a-week, follow-the-manual type of laboratory work presents a routine and security for teacher and pupils from which it is difficult to break away. A new scheme will need to be approached gradually, and one should not be discouraged and inclined to go back to the old, if the first attempt does not run as smoothly as could be desired.

The proposed laboratory plan will take more time and planning on the part of teacher—good teaching is always expensive in time and energy. Pupils are in this plan encouraged to think, —they cannot just "follow directions." Thinking is hard work, —and often it is a new experience for high school pupils who have been so used to memorizing, and giving back just what teacher wanted. One cannot expect pupils immediately to feel at home in this new type of experience. But once initiated and modified to suit the particular situation, it has the possibility of making the valuable technique and experience of laboratory work more functional in achieving important outcomes in the lives of boys and girls.

SUPERSTITIOUS BELIEFS

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If you were asked whether or not you are superstitious, in all probability you would answer rather indignantly, "Of course not." But try yourself on a few. Do you believe that blondes are more fickle than brunettes? Do you believe that if you receive a chain letter you must keep up the chain or you will have bad luck? Does sleeping in the full light of the moon cause insanity? If thirteen sit at table together will one die before the year is out? Will carrying a rabbit's foot bring you good luck? Is it bad luck to light three cigarettes with one match? Do you believe some pitchers have the Indian sign on some batters? If you were given these and perhaps a hundred more and asked to check those that you agreed with, you would probably find at least a few with which you found no fault. Practically everyone either practices or is influenced by certain superstitions.

The question immediately arises as to what is meant by a superstition. The definitions that have been given are many and varied. In its broadest sense it includes all beliefs which have no scientific foundation, that is, cannot be proved. The interpretation given by Caldwell, Maller, and Lundeen[1] is that a superstition is a belief that ascribes causal relationship to phenomena and objects which bear no such relationship to one another. In a more limited sense it refers to unfounded beliefs having a supernatural element. Under the first definition the belief held by many people that a porcupine will shoot out its quills when hunted or annoyed may be classed as a superstition. This, of course, has nothing of the supernatural in it. It is really only a lack of knowledge concerning the habits of the animal. On the other hand, the belief that death is foretold by the falling of a picture from the wall, depends upon faith in a strange, unknown power over which a person has no control. These two types of superstitions must be carefully distinguished in working with children since methods of eliminating them are different in each case.

I have found that in general there are three types of comments made in relation to the superstition problem. One is that it seems rather foolish to spend so much time on a question of

[1] Maller, J. B., and Lundeen, G. E., "Sources of Superstitious Beliefs," *Journal of Educational Research*, XXVI (1933), p. 321.

so little importance and that superstitions seem to have become more or less of an intermediate school hobby. First and foremost, fighting superstitions is not a hobby, something to be carried along as a side line of daily science teaching. It *is* science teaching in its truest sense. We cannot get away from the fact that a superstitious attitude on the part of an individual indicates lack of ability to sense true cause and effect relationships, and is therefore the exact opposite of a scientific attitude. Scientific attitudes necessitate unbiased, clear thinking, an open mind, a willingness to withhold judgment until all possible evidence has been considered, criticized and weighed as to its reliability and relationship to other elements of the problem. Are these items not a part of our goal in teaching science? The superstitions in themselves may not be important but the type of thinking they are indicative of is important and warrants any amount of time spent in correcting it.

The second comment that is frequently heard is: "Why should the exact science department be responsible for this job of eliminating superstitions?" It should not be wholly responsible, of course. But when we consider that the large majority of superstitions deal with natural science topics, that one of our aims is to teach true cause and effect relationships and scientific method, and that we call ourselves the "exact" science department, it would seem only natural that we carry this as a part of our job.

The third comment that is made is that nothing can be done about superstitions anyway. I will make no statement concerning this at this point except to say that I definitely do not agree. My reasons will be given later.

There are, of course, endless numbers of superstitions. In the library you will find whole volumes devoted to them. They have been collected and cataloged by the hundreds according to countries, types, and sources. We find that superstitions which are common in one country are often utterly unheard of or scoffed at in another. It is even true that what is a symbol of bad luck in one locality may be a sign of good luck in another. From studies that have been made in different parts of this country, especially our more backward localities, we find this variation very evident. Just how far this holds true in a large city where many different nationality groups are represented I am not prepared to say at this time. It is probable that intermingling has occurred to such an extent that the lists of super-

stitions from each group will not be distinctly representative, but will overlap.

We are apt to think that belief in superstitions is only found among savages or among those of little intelligence or among those living in backward localities. This is not true. Our cities, in spite of their fine modern schools, are graduating boys and girls who believe a surprising number of these strange ideas. The results of my first study[2] carried out in a Detroit junior high school with 285 ninth grade pupils showed that on the Zapf Superstition Test of 100 items, the mean number believed was 17.0, with 19.1 for the girls and 14.5 for the boys. The scores ranged from 0 to close to 100. The present study was made with a new but very similar 100 item superstition test. In this group of 1143 ninth grade pupils, drawn from nine different intermediate schools of Detroit, there are only 53 individuals who claim to believe none of the 100 superstitions on the test. The other 1090 scores ranged from 1 to 91, the mean[3] for the entire group being 20.6.

Many studies have been made showing a comparison between the intelligence of a child and his belief in superstitions. As far as I have been able to ascertain, the results of these have indicated that there is no relationship between the two, or if any, it is a very small negative correlation. In my present study I have not as yet determined the coefficient of correlation on this point. When I divide my group according to intelligence, however, and find the mean score for each level, a rather definite trend toward an increase of superstitious belief with lower mentality is indicated. All levels of intelligence are, however, well supplied with belief in superstitions. This is shown in Table I.

The question arises as to how young people acquire these superstitious beliefs. Some people unthinkingly say that we were born with them. Obviously this is not true. They were handed down through the ages and were once useful customs. A study by Maller and Lundeen[4] shows that the sources for fostering

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[2] Zapf, R. M., "Superstitions of Junior High School Pupils," *Journal of Educational Research*, XXXI, No. 6 and No. 7.

[3] This score was in terms of the total number of superstitions that a child marked as true. The score which I believe is more indicative of his true superstitiousness is, however, the percentage score determined by dividing the number he believes by the number he has heard before. The mean score figured in this way was 30.8.

[4] Maller, J. B., and Lundeen, G. E., "Sources of Superstitious Beliefs," *Journal of Educational Research*, XXVI (1933), p. 321.

TABLE I
MEAN SUPERSTITION SCORE* ON BASIS OF INTELLIGENCE

*Intelligence***	*Score*	*Number of Cases*
A	21.0	209
B	22.9	146
C+	30.7	214
C	35.2	310
C−	36.5	163
D	42.0	56
E	37.5	45
D and E	39.1	101

* Score is here indicated by number of superstitions believed divided by number heard before taking test.

** Intelligence determined by raw score on intelligence test divided by age of child.

superstitions are in the following order: (1) friends, (2) home, (3) observation, (4) education. In how far different home environments, different cultures, different economic and social standings affect the development of superstitious beliefs I cannot say at this time as the data is not complete.

The same study by Maller and Lundeen shows that the order for eradicating superstitions is as follows: (1) observation, (2) education, (3) home, (4) friends. Thus education holds a high place in eliminating false beliefs. However, when we limit the educational field to science alone, the picture is not quite so pleasing. In my earlier study a 50 item superstition test was given to 546 ninth grade pupils. These were then divided into groups according to the number of semesters of general science they had had previous to the time of taking the test. Results indicated that those having had five semesters of general science had practically as many superstitions as those having had only one semester of science work. It was true that the four teachers who had taught these pupils had given no definite instruction in scientific methods of thinking and problem solving. All, however, felt that they had incorporated these ideas into their teaching in an indirect way. It was discouraging, to say the least.

The present study in which the 100 item test was used in the same way, but was given to about twice as many pupils, gives somewhat different results. The results derived from these data are given in Table II.

If, in place of using this percentage superstition score, we use the total number of superstitions believed and compare these

figures for varying amounts of science we find the same type of decrease, one semester having a mean of 24.3 superstitions while five semesters have a mean of 18.4, a decrease of approximately 6 superstitions.

TABLE II

MEAN SUPERSTITION SCORE* ON BASIS OF NUMBER SEMESTERS SCIENCE

Number Semesters	*Mean Scores*	*Number of Cases*
1	35.8	178
2	39.2	83
3	21.1	127
4	33.8	275
5	27.7	455

* Number of superstitions believed divided by number heard.

Although there is considerable variation from one group to another, there is a slight drop. It is a little difficult, too, to give general science all the credit for this decrease since these pupils have all been exposed to so many other influences. It would seem, however, that our science teaching should have more effect than this. Indirect, subtle methods are apparently slow, cumbrous ways of handling the problem.

Attitudes, whether scientific or otherwise, are habits of thinking and they develop only by slow, steady practice. If we want to develop scientific attitudes, we must work directly toward that and give practice in using scientific methods. If we want to eliminate superstitions, we must work definitely in that direction. The material must be taught in such a way as to attain the goal we have in mind. We cannot trust to chance.

The phrase *scientific attitude* or *scientific method* is familiar to all of us. But to many teachers it is something they hear about, read about, sincerely believe in, and do nothing about. They feel that it is too vague and difficult to handle. It is true that so far educators have met with little success in defining a scientific attitude. They have, however, analyzed scientific behavior and determined items which are embodied in such an attitude. They have found among other things, as was stated earlier in this paper, that scientific attitudes necessitate habits of clear thinking, open-mindedness, careful observation of data, suspended judgment, criticism, weighing of evidence and a search for true cause and effect relationships. For pupils of junior high school age these elements must be simplified to the point of understanding.

The following six questions were therefore developed to serve as a problem solving guide in the experimental groups:

1. What do you want to find out?
2. What have you ever experienced, heard, or read about this?
3. What do you think the answer is?
4. What plan can you make for testing the truth of your answer?
5. What facts have you found?
6. Considering all these facts, what do you now feel is the correct answer to your problem?

The questions were mimeographed with spaces for writing between questions. Each child was supplied with his own sheet for every problem dealt with during the semester, whether it was a superstition or a problem in the regular science work.

The direct attack on superstitions was divided into two types of work, trial and discussion, and discussion alone. The superstitions that were tried out in class and results reported on by those participating were: breaking a mirror, opening an umbrella indoors, walking under a ladder, the groundhog's ability as a weather prophet, and the danger of the number 13. Later in the semester each class was divided into groups of five or six members, each group selecting a superstition to investigate. Discussion of ten other superstitions, without any trial, was carried on at different times during the term.

At the end of the term the 285 ninth grade pupils who had spent two hours each week following the special method of instruction were retested with the Zapf 100 item test. The differences between the initial and final tests can be seen in Table III.

TABLE III

COMPARISON OF MEAN SCORES AND STANDARD DEVIATION ON ZAPF SUPERSTITION TEST GIVEN IN JANUARY AND MAY, 1935

	January		*May*		*Difference in Means*	*Difference in S. D.*
	Mean	*S.D.*	*Mean*	*S.D.*		
Boys	14.5	15.1	5.7	5.8	8.8	9.3
Girls	19.1	17.6	7.5	9.3	11.6	8.3
Total	17.0	16.7	6.6	8.0	10.4	8.7

When the results as shown on this table are compared with the meager decrease in false beliefs which takes place over a

five semester period of time—a decrease of 10.4 superstitions in one term compared with a decrease of 5.9 in five terms—it is obvious that a direct attack on the problem gives the better results. These results would also seem to serve as an answer to the statements made by so many people that it is impossible to do anything about an individual's superstitious beliefs. In so far as paper and pencil testing is reliable, it would seem that a course in general science devoted expressly to the development of scientific attitudes and to the elimination of superstitions is successful.

With the idea of comparing written responses with behavior responses in actual situations, the following procedure was used. The following twelve superstitions which could be developed into actual situations were chosen for testing.

1. Three is a lucky number.
2. Opening an umbrella indoors is bad luck.
3. If you spill salt, you must throw a pinch of it over your left shoulder or you will quarrel with a friend.
4. Always put your right shoe on before your left shoe or you will have bad luck.
5. Walking under a ladder will bring bad luck.
6. See a pin, pick it up,
   All day long have good luck.
   See a pin, and let it lie,
   Before evening you will cry.
7. Horse hairs will turn into horse hair snakes if put in water.
8. Breaking a mirror will bring bad luck.
9. Number 7 is a lucky number.
10. A rabbit's foot will bring good luck.
11. Make a wish while breaking a wishbone with a friend. If you get the larger piece, your wish will come true.
12. Thirteen is an unlucky number.

This experiment has been tried with only 32 pupils to date. Those selected are all individuals who have stated on the superstition test that they do not believe the twelve superstitions listed above. They are sent individually into an observation room where I can see them but they cannot see me. On a table are 13 boxes numbered from 1 to 13. The directions that have been given to the pupils previous to entering the room are:

On the table is a row of boxes. You are to sit at the table and open each of these, starting with number one, and follow the directions inside the

cover of each box. You will be all alone in the room. No one can see you at all. If you are told to do any things which you do not care to do, that is all right. Just don't do them. Write what you did after each one on the paper that is given you. Do not sign your name to this paper.

In this way the child made a record of what he did, or what he wanted you to think he did. A record was also kept by the observer of his behavior and although no names were attached, the pupils were numbered and thus an account was kept of who they were.

The directions within the boxes were similar to the following:

Breaking a mirror is said to bring seven years of bad luck. If you don't believe this, take the hammer and break the mirror that is in this box. If you would rather not do this, put the mirror back in the box.

In this way the child faced a more or less actual situation and had to make a response of some sort to it. Even this, of course, is not the same as having the experience in some more natural environment. The results, nevertheless, are quite interesting. Remembering that all 32 pupils had stated that they did not believe these 12 superstitions, it is perhaps surprising to find that only two showed no belief in any of them in the actual test. Results are given in Table IV.

TABLE IV

PUPILS INDICATING SUPERSTITIOUS BELIEFS IN 12 ACTUAL SITUATIONS

Number of Superstitions Believed	*Number of Pupils*
0	2
1	13
2	7
3	6
4	2
5	2

These results are, of course, an indication of how difficult it is to determine the accuracy of paper and pencil results. Even after we have apparently wiped out a child's belief in certain false ideas, we cannot tell whether it is actually gone unless we see what he does when he meets the situation by himself outside of the classroom. And this we cannot do.

I still feel, however, that no matter how uncertain we are of our results, the attempt must still be made. It should not be made as I am making it. This is experimental and, as such, must be controlled as carefully as possible, and the entire procedure packed into one semester. It should be started far down in the

elementary school and carried on little by little, but steadily and continuously up through the grades. Superstitions should be discussed as they arise in connection with the various science units. Methods should be developed for teaching scientific thinking and acting. We cannot attain 100% success, but even 1/10 of 1% is better than none.

THE THIRTY-EIGHTH ANNUAL CONVENTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

HAROLD H. METCALF, *Secretary*
Oak Park, River Forest Township High School

The thirty-eighth annual convention of the Central Association of Science and Mathematics Teachers was held on November 25th and 26th in the LaSalle Hotel in Chicago, Illinois.

The many new innovations in the program, the well planned exhibits, and the excellent presentation of papers sent those who attended home with renewed enthusiasm for their work. Much credit is due Professor Ira C. Davis of the University of Wisconsin who, as president of the Association, gave liberally of himself and his time during the year preceding as well as at the convention. The exhibitors put on demonstrations when meetings were not being held. In each section, the last speaker discussed and demonstrated New Materials and Equipment. On Saturday morning, after a general meeting, the elementary school, the junior high school, the senior high school, and the junior college each held sectional meetings in which problems in science and mathematics teaching were discussed. These new features enriched the program immeasurably. A new record of attendance was set, approximately 1000 attending.

The Board of Directors adopted some very important steps which will keep our Association a leader in the fields of teaching of science and mathematics. These will be found later in the report. Those Directors present were: Ira C. Davis; J. M. Kinney, vice president; W. R. Teeters; Walter H. Carnahan; Theodore D. Kelsey; H. Clyde Krenerick; Nathan A. Neal; E. O. Bowers; George E. Hawkins; C. J. Leonard; J. S. Georges; Ersie S. Martin; Marie Sangernebo Wilcox; and Harold H. Metcalf, secretary.

Although space does not allow for the mentioning of all who helped plan the convention, the following committee chairmen are to be commended: Paul G. Edwards, who did much of the planning for the teachers of Chicago; Anna M. Olsen; Joseph Dickman; Nicholas Cheronis; Ralph D. Garrette; R. E. Davis; Glenn F. Hewitt; R. E. Whitney; Edward C. Schwachtgen; J. S. Georges; E. O. Bowers; and Ray C. Soliday.

THE FRIDAY MORNING GENERAL SESSION

SCHOOL SCIENCE AND MATHEMATICS will carry the manuscripts of the speeches given at the convention. No attempt will be made in this report to cover any of the meetings in detail.

Mr. Nathan A. Neal was kind enough to report the Friday morning talks for the secretary.

Dr. Morris Meister, Bronx High School of Science, New York City, spoke on The Program of Science in 1950. Briefly, he predicted that any change which occurs between now and 1950 in science education is certain

to be gradual and likely to be for the better. There will not be any radical departures. Classes should be smaller and the teaching should be more leisurely and more artistic. Teachers should be trained carefully in the manner of more artistic teaching. There is entirely too much college level material now being used in the high school field. It should be put back where it belongs, in the college, in order to bring about this more leisurely and artistic teaching. Science laboratories in 1950 will be rooms where students are free to go at any time that they wish the solution for a problem which is real to them, and not rooms with stalls, where a student follows exact directions and does the same thing as all of his fellow students. Scientific Attitudes should be emphasized and will become a more important part of the new artistic teaching.

Dr. Francis O. Schmitt, Professor of Zoology, Washington University, St. Louis, discussed Recent Applications of Physics and Chemistry in Biology.

In the past 15 or 20 years, Physics and Chemistry have become increasingly important in research in Biology and Medicine. Delicate electrical measurements and measuring devices have brought much new knowledge of the causes for various nervous and muscular difficulties. The fundamental fact that a potential difference exists between the inside and outside of a cell has been known for almost 100 years; only recently, however, have measuring devices become sufficiently accurate to make it possible for this knowledge to be applied in further research. Modern instruments enable us to learn much of the exact molecular nature of various types of body cells. This in turn has a possibility of leading, eventually, to a solution of many of our present day unsolved problems concerning living phenomena.

Professor Rudolph E. Langer of the University of Wisconsin gave a scholarly biography of Josiah Willard Gibbs, an American Scientist and Mathematician. Born of a well to do family, Gibbs did not have to work for a living but spent his life in study. He served Yale as Professor of Mathematics and became the outstanding man in this country in the field of thermodynamics. Shy and unassuming, he seldom consulted others and his thoughts were seldom known until he published a brilliant monograph. He laid the foundations for much of the work in the fields of science and mathematics which came later.

BIOLOGY SECTION

The Biology Section was called to order November 25, 1938, at 2 P.M. by the Chairman, Lillian Bondurant. The Secretary, Esther D. Olson, was also present.

The Nominating Committee, consisting of the following members: J. W. Kendricks, E. S. Gould and Miss Catherine Sturm, was appointed by the Chairman.

The first speaker was Mr. C. E. Godshalk, Superintendent of the Morton Arboretum. Mr. Godshalk spoke of the development and the purpose of the Arboretum. The Morton Arboretum was founded in 1931 by Mr. J. Morton, son of J. Sterling Morton, the founder of Arbor Day. The purpose of the Arboretum is to further scientific research in horticulture, particularly in the growth and culture of the trees and shrubs of the world able to stand the climate of Northern Illinois. For the purpose of study, the plantings have been arranged according to four groupings:

1. In systematic groups, defined by botanical relationships.
2. In geographical groups, according to native habitats.
3. In ornamental plantings to create landscape effects.
4. In economic plots, where trees are tested for timber value.

Services offered to the public are: Information concerning plants and planting problems, permission to examine specimens in the Herbarium, and the use of reference books on horticulture and arboriculture. During the summer months a free bus and a guide may be had by groups who wish to travel over the many miles of woodland roads. People from many parts of the world have studied the plantings at the Arboretum. Mr. Godshalk showed many beautiful colored slides of trees, bursting with bloom in spring, trees in their glorious fall colors, and trees decked in downy snow. The pictures of the wild flowers carpeting the meadows and woodlands were inspiring. Other slides showed sections of the Morton Arboretum before any planting was done, and as they appear today. The "Before and After" pictures were concrete illustrations of the magic that may be accomplished when man cooperates with nature to build for usefulness and beauty.

The second speaker was Mr. Silverman, President of the Illinois Silver Fox and Fur Breeders Association, Inc. Silver fox and mink rank first and second in the amount invested and the amount of income in fur-farming today. There are three breeds of foxes, the Eastern Standard, Alaska, and the cross between the Eastern Standard and Alaska. All foxes are quite small. It is their fluffy fur that makes them appear large. Foxes are kept in pens under which is wire netting. The sides are of wire netting, and they overlap 24″ at the top to prevent the animals from climbing out. Foxes are hosts to a number of disease organisms, such as roundworms, hookworms, lung worms and tapeworms. When animals recover from these diseases, they are usually pelted. Foxes have an average of three pups to a litter. The animals grow quickly and in eight months are ready for pelting. Animals are killed with a hypodermic needle or by gas. Great care must be exercised at all times to not injure the fur. Fur pelts raised on fur farms are better than wild pelts because they are taken at the exact time that they are prime. If the pelts are not prime the fur falls out and the pelts are almost worthless.

The report of the Nominating Committee was as follows: Chairman A. C. Brookley, Township High School, Harvey, Illinois. Vice Chairman, Lyle Stewart, Oak Park River Forest High School, Oak Park, Illinois. Secretary, Florence A. Gates, Libbey High School, Toledo, Ohio. The report was accepted.

The next speaker was Mr. John Y. Beaty, Editor, Author, Naturalist, who spoke on the strange things in nature, and showed how the Biology teacher could put these to classroom use. The speaker said that strange things are remembered best and illustrate biological principles as well as commonplace things. Some of the strange things discussed were: The changing color of the squid, the white Ptarmigan in winter that is ground color in fall, the spider's silken thread, the white horse that was born black, the keen sense of hearing of whales, and the bat's graveyard. One does not need to go farther than the back yard to find strange animals for study. The speaker gave a formula for learning about things. The first thing to do is to read extensively on the subject, then find an expert to talk with about it, next, go out and get first-hand experience for yourself. Then go out and tell anybody who will listen about it. Last, write about what you have learned.

Mr. H. G. McMullen, of the University High School, Madison, Wisconsin, spoke on the new materials available for Biology teachers. He presented each person at the meeting with a mimeographed outline of available materials in textbooks, work books, method books, apparatus, charts, sound films, specimens, radio, bulletins, magazines, and service leaflets. The speaker discussed some of the listed contributions.

ESTHER D. OLSON, *Secretary*

CHEMISTRY SECTION

The chairman, Raymond R. Whitney, called the meeting to order in a room that was inadequate to hold all of those who wished to attend.

L. G. Weiner, chemist of the American Can Company discussed the Unfamiliar About the Familiar Tin Can. He traced the history of canning from the time that it was attempted early in the 19th century by a French chef. The corrosion of the metal due to the food acids and the effects of metallic salts on the contents of the can were explained. Mr. Weiner looked into the future and made predictions as to the development of alloys that would help solve canning problems. Until more perfect metals are found, tin plate will continue to be in great demand. Those who heard the discussion are looking forward to a visit to the can manufacturing laboratories.

The nominating committee consisting of R. E. Davis, W. H. McLain, and S. R. Wilson made the following recommendation which was accepted by the members: for chairman, Ernestine M. J. Long; vice chairman, Ray L. Harkins; secretary, Ray C. Soliday.

Dr. B. S. Hopkins, Professor of Chemistry, University of Illinois, addressed the Section. His topic was "The Wisdom of Attempting to Teach the Brönsted Nomenclature." With clarity, enthusiasm and no little humor Dr. Hopkins kept his tense, eager audience avidly interested throughout. He felt quite decidedly that secondary school teachers should inform themselves about the Brönsted nomenclature but he felt that they should not attempt to present both theories. Secure a good basic text and follow it was his advice to teachers. Until a good text is written covering the Brönsted Theory, it was felt that high school teachers had better stick to the Arrhenius Theory. This paper should be read by every high school teacher of chemistry. His explanation of the Brönsted Theory deserves to be printed and reprinted in places where all high school chemistry teachers may have access to it.

"Pupil Play-Around or Demon-Shaping Dictator" sounded intriguing and was presented by H. R. Smith, Lake View High School, Chicago, Illinois. Mr. Smith advocated using both the laboratory and lecture demonstration methods of teaching. During the discussion Professor Frank, State Teachers College, Oshkosh, Wisconsin stated that past research on the subject of laboratory versus lecture demonstration methods was not valid because studies had not considered all four variables, namely that principles, teacher, personality, students, and the past learning experiences of students all vary with individuals. His plea was to give the child more responsibility.

"Experiences in Consumer Science Instruction" was given by M. C. Crew, Austin High School, Chicago, Illinois. Mr. Crew pointed out that "Consumer Chemistry gives the pupil some practice in problem solving, and the techniques which are best adapted to solution of problems within the field of chemistry, especially those which most often present themselves in daily life. This means the development and use of the scientific method by the pupil. Furthermore, this work from the point of view of the consumer will help the pupil develop those attitudes toward ways and methods of investigation which will aid in developing a definite consumer consciousness and therefore help shape his economic life more to his satisfaction" Examples of student projects were cited.

ERNESTINE M. J. LONG

ELEMENTARY SCIENCE SECTION

W. C. Croxton discussed Functional Outcomes and Purposeful Activities in Elementary Science. He suggested means of achieving the following outcomes of the teaching of elementary science.

(1) to develop in the child the tendency to immediately find satisfaction and recreation in hobbies and leisure time activities.
(2) to develop in the child certain habits and abilities for his protection and efficiency.
(3) to develop in the child social attitudes, appreciations, and habits of service to society.
(4) to contribute meaning to the child in the elementary school which leads to broader concepts.
(5) to develop scientific attitudes and habits of procedure.

Whit Brogan discussed Science and Arithmetic in the Elementary School Curriculum. He stressed science rather than arithmetic. Science helps the child answer questions and develops a method of inquiry.

Veva McAtee discussed Materials and Equipment for the Teachers of Elementary Science. Her discussion of effective devices with which to enrich and vitalize the teaching of elementary science was accompanied by a mimeographed compilation of references, visual aids, and simple apparatus.

The officers for next year are: chairman, Veva McAtee; vice chairman, W. C. Croxton; secretary, Mrs. Margaret Witt.

VEVA MCATEE, *Secretary*

GENERAL SCIENCE SECTION

Theodore J. Kuemmerlein, the chairman, called the meeting to order. The secretary, Pauline Royt, and the vice chairman, Herbert A. Grabau, were also present.

Rosalind M. Zapf of the Cleveland Intermediate School, Detroit, Michigan, talked on Superstitious Beliefs. Many persons have questioned Miss Zapf about the value of her work. They maintain that nothing can be done about the superstitious beliefs of students. Most teachers have not touched upon the problem directly. By attacking the problem directly she showed through her results that changes can be made in the child's beliefs. At present science is not eliminating superstitions and Miss Zapf questioned the teachers as to whether they really were trying to teach the scientific method or merely reading about it. She gave six simple questions outlining the problem solving method.

Dr. Morris Meister of the Bronx High School of Science, New York City, gave many teaching guides in his talk on Demonstration Teaching—New and Old. Dr. Meister maintains that teaching by the demonstration method is an art which science teachers should try and develop. He says that there is a tremendous need for concerted action of science teachers in compiling a book on demonstrations which will give to the teacher the technique of the demonstration. He gave a list of many techniques which can be used in presenting a demonstration—such as—approach technique—effectiveness depends on approach; approach technique—by way of surprise; approach by realness of experience; approach technique—to make an invisible process visible; climatic series technique—simple series of demonstrations leading to the climax; analyze demonstration—demonstration should be graded for number of problems involved; analyze for multiplicity—experiences they will derive; assemblying technique—build before their eyes; control technique—using a control; home work technique—getting child to do experiment at home; pantomine technique and review lessons. Dr. Meister maintains that demonstrations can be planned for the following purposes: to raise problems, to illustrate ideas, to review topics, to answer a question, to do home work, and to test knowledge. In

closing he gave the following demonstration hints: 1) teacher should rehearse demonstration, 2) present only one experiment at a time, keeping additional materials away from the main picture, 3) have a large white cardboard handy so that you can use it as a background to increase visibility, 4) assemble apparatus before their eyes, 5) use pupil assistance, 6) use apparatus brought in from home, 7) ask students to suggest alterations, 8) instruct them in simple note taking, 9) minimize teacher talk during demonstration—pantomine if possible, 10) let vividness, visibility, and simplicity be your motto.

Harold Stamm of West Allis High School, West Allis, Wisconsin gave an illustrated talk on The Interest of the Child. Mr. Stamm believes that science students are leaving our schools without the necessary knowledge for the appreciation and understanding of the things in their environment. Many times a direct individual question will stimulate a child to activity and consequently the entire class. Do not expect the child to come to you well prepared. Start at the beginning—at a low enough level so that he can grasp the material presented. Mr. Stamm's fine pictures were proof of the interest he was able to arouse in home and school activities.

The nominating committee consisting of H. M. Kuckuk, and Carl Enger made its report which was accepted. Chairman, Herbert A. Grabau, Lincoln High School, Des Moines, Iowa; vice chairman, Pauline Royt, Horace Mann Junior High School, West Allis, Wisconsin; and Secretary, R. Emmerson Park, River Forest Twp. High School, Oak Park, Illinois.

A new feature called "New Equipment in General Science" was given by Lawrence H. Fuller. He called attention to the equipment that the exhibitors had that would be of interest to general science teachers. He also urged the teachers to visit the Museum of Science and Industy in Jackson Park because of the valuable displays and demonstrations there.

PAULINE ROYT, *Secretary*

GEOGRAPHY SECTION

The meeting was called to order by Miss Helen Turner at 2:00 P.M. and a nominating committee consisting of Miss H. A. Southgate and Mrs. Viva Dutton Martin was appointed.

The first speaker, Dr. Edwin H. Reader, professor of education, University of Illinois, had as his topic, "The Geography Teachers' Responsibility in Teaching Citizenship." He showed the need of clear minded disillusionment in the concept of the infinity of the United States. The resources of the United States when the white man first came were contrasted with those left after 300 years. We might well take a lesson from China. The book, *Rich Man Poor Man*, by Stuart Chase, was recommended for reading.

Miss Ethel Mills, of Soldan High School of St. Louis, presented the topic, "U. S. Highway 66—A Geographical Survey," which was illustrated. The project was worked out by four members of the Ellsworth chapter of the Junior Academy of Science of St. Louis. The highway was studied from the standpoint of topographic adjustments as cuts, fills, curves, construction of road. ditches and bridges, use, and beautification.

The new officers for 1939 are Chairman, Miss Ethel Mills; Vice Chairman, L. R. Allen of Indianapolis Technical High School; and Secretary, Helen Lyle, of Wilson School of Cicero, Illinois.

Mrs. R. W. Mikesell, Pestallozi and Froebel Training School, Chicago, Illinois, had as her subject, "New Materials and Equipment for Teaching of Geography." After contrasting the old geography text books with the

new, she presented the names of new text books suitable for elementary, secondary, and college levels. She also presented a list of books for geography teachers and a list of books on available geography materials.

ETHEL MILLS, *Secretary*

MATHEMATICS SECTION

Mr. Harold E. Spross, the chairman of the mathematics section of the Central Association of Science and Mathematics, called the meeting to order in the East Exhibit Hall of the Hotel LaSalle, Chicago, Illinois, at 2:00 P.M. on Friday November 25th. The vice chairman. Mr. J. J. Urbancek, and the secretary, Miss Ida D. Fogelson, were both present. Mr. Urbancek announced the mathematics exhibits now being shown in the Adler Planetarium. Then Mr. Spross appointed the nominating committee consisting of Mr. M. J. Newell, Evanston High School, Evanston, Illinois, Mr. E. O. Bower, East Technical High School, Cleveland, Ohio, Mr. Arthur Sims, Washington High School, Indianapolis, Indiana.

Professor H. C. Christofferson of Miami University and President of the National Council of Teachers of Mathematics opened the program with the subject of "Functional Relationships in Elementary Algebra." Such relationships, he advocated, could only be obtained if pupils were taught functional thinking. They should first be taught the concept of a variable, and the dependence of one variable upon another. They should then be shown that if two sets of quantities or two variables are so related that the knowing one of them determines the other or enables the pupil to figure out the other, then there is a functional relationship between the quantities. To complete the functional thinking this relationship should be expressed in a formula or in a graph. Thus if problems in algebra could be analyzed in showing the dependence of variables and in expressing this dependence, then functional thinking would give large dividends in terms of mathematical appreciation, mathematical reasoning, and mathematical insight.

The second paper, on "The Necessary and Sufficient Conditions in Elementary Mathematics" was presented by Professor Karl Menger, formerly Professor of Mathematics at the University of Vienna, and now Acting Chairman of the Department of Mathematics at the University of Notre Dame. The speaker showed that in many cases conditions whose necessity had been proved were not sufficient, and that conditions which had been proved to be sufficient were not necessary. The confusion of these two types of conditions may lead to serious mistakes.

The third speaker on the program was Mr. Charles M. Austin, High School, Oak Park, Illinois. His paper entitled "Motivating High School Mathematics" showed the importance of geometry, algebra, and arithmetic in the daily life of an individual. Because of this importance he held it was the duty of every teacher so to motivate the subject that every type pupil, regardless of his prejudices and misconceptions of the subject, would be guided to appreciate the value and usefulness of the study of mathematics. Mr. Austin showed how the analytical thinking acquired in geometry became the mental equipment of an individual in solving life situations. He gave many practical examples of situations based on such geometric facts, as: (a) Sum of the Angles of a Triangle and other Polygons, (b) Ratio and Proportion, (c) Pythagorean Theorem, (d) Rigidity of the Triangle, (e) Area Formulas, (f) Similarity, (g) Measuring Inaccessible Distances, (h) Principles of Construction, etc. Thus the nature of the proof, the precise and accurate use of words and their application to daily life was sufficient evidence of the importance of geometry in the curriculum. Also, algebra through the use of symbols and the symbolic method of

thinking, and arithmetic, with its number system as a universal scientific language to cope with all situations, gave conclusive proof that mathematics interprets the economic and scientific environment for the individual, therefore making mathematics the foundation of all knowledge.

Mr. R. L. Short of the Ashland Intermediate School, St. Louis, Missouri, delivered the fourth paper on "Methods in Arithmetic and Algebra." Mr. Short described his system of teaching arithmetic from the second grade on through algebra in the high school. From the very beginning quick work and accuracy in the fundamental operations were demanded. He illustrated his talk by showing the short cuts, the drills, and the methods he uses to make the subject of mathematics one of speed and of interest to the pupils.

The last paper on the program was read by Mr. Bjarne Ullsvik, University High School, Madison, Wisconsin, on "New Materials and Equipment for the Teaching of Mathematics." His bibliography contained materials on arithmetic; on publications in periodicals, which was divided into three categories, (1) administrative, philosophical or research, (2) curricular, and (3) pedagogical; on available motion pictures; on the literature on motion pictures; on posters; on classroom tests; on introductory college texts; and on all types of supplementary mathematics material. The evaluation of each division in the bibliography showed its contribution in the development of the individual through the intergration of mathematics with other subjects in the curriculum.

The report of the nominating committee was accepted. The officers of the Mathematics Section for the next year are as follows: Chairman: Mr. J. J. Urbancek, Lane Technical High School, Chicago, Illinois; Vice Chairman: Miss Ida D. Fogelson, Bowen High School, Chicago, Illinois; Secretary: Miss Martha Hunt, Shortridge High School, Indianapolis, Indiana. The meeting was then adjourned.

Respectfully submitted,
IDA D. FOGELSON, *Secretary*

PHYSICS SECTION

The physics section was called to order at 2:00 P.M. by the chairman, James P. Fitzwater. Ersie S. Martin, vice chairman, and Ray Lambert, secretary, were present.

Dr. G. W. Warner, of Wilson Jr. College, was called upon for an announcement. He presented a tentative list of books suitable for high school libraries which is being sponsored by The American Association of Physics Teachers under the direction of Dr. Duane Roller, Editor of *The American Physics Teacher*. E. E. Burns, R. B. Zika, and K. E. Vordenberg were appointed as a committee to consider this matter.

Prof. W. S. Webb, of the University of Kentucky, spoke on the topic, Physics as a Cultural Subject. After defining culture as one's relation to environment, Prof. Webb described a method of teaching physics by lecture-demonstration. He uses no text but makes extensive use of the library. Physics is employed as a means to teach the scientific method, emphasis being placed upon the curiosity of the pupil as a means of arousing interest. The success of Prof. Webb's approach to the teaching of physics is indicated by the fact that about ten per cent of the students of a large university are found, each year, in the physics classes.

Mr. Haym Kruglak, of the Milwaukee Vocational School, read a paper entitled, The Specialized Field Trip. After mentioning the general field trip which has its greatest usefulness in the grades, he explained the steps necessary to make the specialized field trip of greatest value to a physics class. These steps include: a class discussion of the principle to be observed,

choosing a particular application of this principle, a trip to the plant before taking the class, a questionnaire to be filled by the pupils while on the trip, checking of data the day following the trip, and, finally, a written report by each pupil.

Prof. G. P. Cahoon, of Ohio State University, read the paper, How Can the Content and Teaching of Physics Courses Be Made More Functional? Prof. Cahoon made a plea for the adaptation of the physics laboratory to desirable educational outcomes. The laboratory should be used as a means to an end. The schedule should be made flexible so that laboratory work may be given when required by educational objectives. The participation of the pupil is of greatest importance, no laboratory manual should be used, and no written report should be required. A short test may be used to check on pupil understanding and accomplishment.

Mr. A. H. Gould, of the Boys' Technical High School, Milwaukee, Wisconsin, presented a paper on New Apparatus and Materials for the Teaching of Physics. Among the devices described were: a new apparatus for demonstrating the laws of motion, wind rotor, floating magnets, Rochelle salt crystal mounted with a neon lamp, resonance indicator, mercury lamp, slit image projector, and Compton's chart of the electromagnetic spectra.

The nominating committee, consisting of Walter E. Peterson, Ersie S. Martin, and John K. Skinner, made its report which was accepted. The following officers were elected: Chairman, Ray Lambert, Walnut Hills High School, Cincinnati, Ohio; Vice Chairman, O. C. Osborn, Central Senior High School, South Bend, Indiana; Secretary, George E. O. Peterson, Schurz High School, Chicago, Illinois.

RAY LAMBERT, *Secretary*

THE ANNUAL DINNER AND DEMONSTRATION LECTURE

Paul G. Edwards, director of visual education in the Chicago public schools, acted as toastmaster at the banquet which was characterized by few but excellent numbers. The Hirsch High School Choir sang beautifully and Miss Jeanne Fay captivated her audience with her charm and grace in her dance. Miss Anna Olsen and her committee are to be congratulated on the metal favors indicative of the various phases of science, on the unique programs, and on the efficient handling of the many details.

Dr. J. O. Perrine's demonstration lecture on Words, Wires, and Waves was a highlight of the convention. As an official of the American Telephone and Telegraph Company, he was able to bring with him thousands of dollars' worth of equipment, skilled operators, and a wealth of knowledge not only of the field of communication but also of how to convey his ideas to the audience. He discussed at some length the production of sounds by vocal chords, the use of vowels and consonants in speech, and the reproduction of these sounds by amplifying instruments. Various types of speech, instrumental music, and vocal music were amplified and changed by cutting out certain of the wave lengths. Two circuits to and from New York by wire were opened up and the types of sound best suited for transmitting ordinary speech, and for broadcast work were shown. The history of telephony was discussed and illustrated. It is not an exaggeration to say that people who heard Dr. Perrine will be redoing his lecture in their class rooms for years to come.

SATURDAY MORNING BUSINESS SESSION

Charles S. Webb, chairman of the Necrology Committee made the following report, which was accepted as read.

REPORT OF THE NECROLOGY COMMITTEE

Recommendations of the Necrology Committee as to the permanent policy of the committee:

1. We recommend in the interest of some degree of uniformity of procedure and continuity of policy, either a rotating committee whose members are appointed for different periods, or at least the retention of one or more members from year to year.

2. We recommend that as soon as the death of a member comes to the attention of the Business Manager of the Journal, he transmit this information to the chairman of the Necrology Committee whose duty it will be to see that a suitable obituary be prepared and submitted for publication in the Journal.

3. We recommend that instead of the reading of these obituaries at the busy Saturday morning session, the list of members who have died during the year be read, as was done this year, at the Friday morning session, the whole assembly rising as a mark of respect. Signed: Charles S. Webb, Charles W. Franklin, Hans Gutekunst, and Herbert R. Smith.

Since the last meeting of the Central Association of Science and Mathematics Teachers death has taken two of our past presidents: James H. Smith and Herbert E. Cobb.

JAMES H. SMITH

The commemorative article concerning Mr. Smith in the February issue of SCHOOL SCIENCE AND MATHEMATICS seems appropriate to this report:

"James H. Smith of Chicago, for many years assistant principal of Austin High School, died at his home on Thursday, Dec. 2, 1937.

"Mr. Smith was president of the Central Association of Science and Mathematics Teachers during the two successive years of 1909 and 1910. He was a familiar figure at every meeting for a great many years and hundreds of the members valued his friendship and help. He was always willing to give support to whatever project the Association undertook.

"Mr. Smith was born at Massillon, Ohio in 1862. He attended Oberlin College, the University of Michigan, Johns Hopkins University and the University of Chicago. In 1900 he became a physical geography teacher at Austin High School. In 1911 he became assistant principal and in 1916 he was made principal of the night school. He was active in both of these positions until his retirement in 1932."

HERBERT E. COBB

Herbert E. Cobb, formerly professor of mathematics at Lewis Institute, died at his boyhood home in Searsmont, Maine on March 1, 1938 at the age of 77. He had resigned his work in 1932 and had spent the remaining years of his life in the home of his brother, Eben Cobb.

He received the Bachelor of Arts and Master's degrees from Wesleyan University, Middleton, Conn. In 1890 he came west to be instructor in the University of Colorado for two years. At the University of Chicago he taught until 1896. Then he began his work at Lewis Institute.

After a year at the University of Berlin in 1905–6 he became actively engaged in the work of the Central Association of Science and Mathematics Teachers and for many years he was one of its most influential members. In 1911 he directed its activities as President. Only four times has the Association reelected a president and to Professor Cobb this honor came as a recognition of distinguished service.

Being a real gentleman and a thorough scholar he had no need of erudition. He placed a living emphasis upon the service of knowledge rather than its tinsel and trappings. The wide circle of pupils, friends and associ-

ates recall his acquaintance with joy and a real appreciation for the kindly direction in the ways of life, and the gifts of fellowship that were so freely bestowed by one of Nature's truest gentlemen.

(The more intimate details of his life may be found in the May number of SCHOOL SCIENCE AND MATHEMATICS, p. 478.)

H. R. SMITH

CHARLES H. PERRINE

The life work of Charles H. Perrine of the Chicago High Schools came to an abrupt end from heart failure while at work in Washington State on June 6, 1938. Retiring from the Chicago system in 1935 at 70 he became Pacific Coast representative for Hall & McCreary Pub. Co. of Chicago. Three most pleasurable and satisfying years traveling in a trailer with his helpmeet, closed the educational career of this self-educated man who had given 43 years of his life to Chicago's youth.

He was born at Wilton Junction, Iowa but moved to a farm near Delaware in south-eastern Indiana at an early age. He attended Moore's Hill College and Franklin College. He worked his way to a bachelor's degree at Northwestern by 1892. He started teaching in Chicago night schools this year and as a regular teacher the next year at South Division where Jeremiah Slocum was principal. He continued his studies in the science field at the University of Chicago and at Armour Inst. he completed a course in electrical engineering.

At the opening of Wendell Phillips High School he became one of the first assistant principals in the city system and principal at the death of Spencer Smith in 1917. This promotion was largely due to the vigorous support of the teachers under him. Frequent other promotions brought this energetic executive to several other schools. Four years at Parker, six at Lake View and four at Medill spread his genius of organization to the various parts of the city. His influence was positive in many educational organizations and improvements that he started are still in use. His personality made him a charter member of the Central Association. Nominal membership was a thing foreign to him. Where he "joined" he acted and for twenty years his influence helped to establish this Association as a major educational force.

Among the appreciated personalities that he had, his frank yet friendly criticism was most evident. He analyzed a situation quickly yet thoughtfully to a conclusion and had the courage to support it. Four graces were quite evident in his decisions: promptness and vigor in action, yet friendliness and justice guided his judgments. He did not wear his heart on his sleeve but he always gave it with his outstretched hand.

H. R. SMITH

WORRALLO WHITNEY

Mr. Worrallo Whitney died at his home in Chicago on March 10 at the age of 79 years. He had retired in 1928 after having taught in Chicago high schools since 1893. During his years of retirement he spent a great deal of time in fruit and flower culture on his farm near Three Oaks, Michigan. He contributed many special articles and book reviews to SCHOOL SCIENCE AND MATHEMATICS which he served for several years as departmental editor of Botany and of Zoology. He collaborated in the publication of Studies of Animal Life in 1900 and A Guide for the Study of Animals in 1911.

From the commemorative article by I. N. VanHise in the May SCHOOL SCIENCE AND MATHEMATICS we quote the following sentiment of appreciation. "To all who ever knew Worrallo Whitney or had worked with him, associated either as scientist, fellow teacher, or interested student, he will always be remembered most tenderly as the quiet gentle teacher, the

kindly gardener and the humble servitor to all living things—to plants, to animals and to his friends and associates.

The new associate editors of the Journal were announced as follows: Botany, A. G. Zander, Boys' Technical H. S. Milwaukee, Wisconsin; Demonstration, Mr. Wm. A. Porter of Chisholm, Minnesota; and Elementary Science, David W. Russell, National College of Education, Evanston, Illinois.

Mr. Krenerick reported that the Place of Meeting Committee unanimously recommended Chicago for the 1939 convention. The report was accepted.

Mr. Soliday, Chairman of the Membership Committee, gave a brief report of the work done during the past year. The results of the work of the committee were evident in the large attendance at this year's convention.

Mr. Gingery reported for W. R. Teeters, chairman of the Nominating Committee, as follows: President, Marie Sangernebo Wilcox, Washington H. S., Indianapolis; Vice President, Nathan A. Neal, James Ford Rhodes H. S., Cleveland, Ohio; Board of Directors, terms to expire in 1941, W. R. Teeters, Board of Education, St. Louis, Missouri; Pauline Royt, Horace Mann Jr. H. S., West Allis, Wisconsin; Franklin Frey, Twp. H. S., Waukegan, Illinois; and H. A. Grabau, Lincoln H. S., Des Moines, Iowa; in place of Lillian Hethershaw Darnell, resigned, Mary Melrose, Bd. of Education, Cleveland, Ohio; and in place of Mrs. Wilcox, J. M. Kinney, Wilson Jr. College, Chicago, Illinois.

Carl Hanske made the report of the Auditing Committee of the accounts of the Secretary-Treasurer. The treasurer's account showed a balance on November 26, 1937 of $492.94; receipts during the year of $365.15; disbursements of $561.69; and a balance on November 25, 1938 of $296.40. The report, was accepted.

The following report of the Resolutions Committee was read by the chairman, E. O. Bowers, and accepted. It is far different than anything done previously by the Resolutions Committee and will have an important effect on the future policy of the Association.

REPORT OF THE RESOLUTIONS COMMITTEE

Resolutions Pertaining to Curriculum—1

RESOLVED that the Central Association of Science and Mathematics Teachers go on record as favoring any study of curriculum in Science and Mathematics working toward a better adaptation of the materials of instruction to the needs and interests of the students, and that we favor the organization of some central agency in the organization to make available to members information regarding any studies or experiments that have been undertaken with a critical evaluation of the results of such studies. And that we further resolve that a committee be appointed by the president to take responsibility for putting into effect the provisions of this resolution; this committee to report to the Board of Directors twice a year, or more often, the results of its work.

Resolution Pertaining to Instructional Materials—2

RESOLVED that we favor the organization of a committee to be appointed by the president to list visual and audio aids available for instruction in mathematics and science, with a brief description of each, and suggestions as to where they can best be used, and to cooperate with publishers and manufacturers in any possible way to develop other aids not now available.

Resolution Pertaining to Research—3

RESOLVED that we favor the appointment by the president of a research committee whose duties it shall be to call the attention of the members of the association through the agency of the Journal, to problems of organization of subject matter and methods of instruction, which will lead to more effective teaching; this committee to report the results of its activities twice a year, or more often.

Resolution Pertaining to Other Organizations—4

RESOLVED that the Central Association offer its cooperation with other organizations, in the Midwest territory, which have as their purpose the furtherance of the interest of science and mathematics, and that a committee be appointed by the president whose duty it shall be to find and contact all such organizations possible in an effort to coordinate the activities of the association, and those of other organizations.

Signed:

MARTHA HILDEBRANDT
BEN BERG
M. C. W. PHILLIPS
WALTER H. CARNAHAN
THOMAS A. MATHIAS
ERNEST O. BOWER, *Chairman*

THE REPORT OF THE CONSERVATION COMMITTEE

Members of the Committee

O. D. Frank, University High School, Chicago, Illinois.
J. L. Cooprider, Central High School, Evansville, Indiana.
L. F. Pinkus, Siegel School, St. Louis, Missouri.
Philip Krause, Washington Park High School, Racine, Wisconsin.
Harold G. McMullen, University High School, Madison, Wisconsin.
Henry C. Wilkins, Central High School, Superior, Wisconsin.
Fred Schriever, Chairman, Boys' Technical High School, Milwaukee, Wisconsin.

This committee, appointed November 29th, 1930, has made seven reports of its findings. With some change in membership, the committee is to continue the study of the question of Conservation Education in the Secondary School Curriculum.

A. The Progress of Conservation

The "conservation idea" is gaining ground in the individual states and throughout the nation.

In Wisconsin, for example, in accordance with the Conservation Education Law of 1935, an excellent bulletin has been issued this year by the Department of Public Instruction entitled, "Helps in Teaching Conservation in Wisconsin Schools." Vol. 1, May, 1938, No. 2.

This bulletin contains a list of activities, a bibliography of reading materials by grades, and teaching helps for elementary grades. Material is being accumulated for teaching units. Teachers are encouraged to help in this important undertaking.

In general, more books are being made available. We are allowed to quote one example: "Teaching Aids in Conservation for the Senior High School," Appleton, Wisconsin, 1938. There is a companion volume for junior high schools. Ohio is also doing excellent work in Conservation.

B. Conservation Activity

Individual members of the conservation committee are working in their respective fields. Also, the committee continues in touch with the American Forestry Association and the national legislation in regard to conservation.

Our committee has been reorganized with three new members. A more aggressive policy should be followed. Various questions need to be answered. (1) What are schools doing with conservation teaching? (2) Are they making it practical in their communities? (3) Who are the people who are doing something in Conservation Education? (4) What units have been developed? (5) What subjects are best adapted to include conservation work?

We favor further articles on conservation, especially those which open up the field of information on this subject to teachers.

Respectfully submitted,
FRED SCHRIEVER, *Chairman*

SATURDAY MORNING GENERAL SESSION

E. A. Taylor of the American Optical Company talked on "How to Improve Science and Mathematics Teaching through Better Reading." He quoted statistics to show the per cent of failures in the various subject fields and the especially high percentage in mathematics. He proved conclusively that many of the failures could be traced directly to reading difficulties. He used diagrams to demonstrate the proper movement of the eyes in reading and referred to the machine which could be used for photographing of eye movements.

Dr. Louise Farwell Davis of the National College of Education of Evanston, Illinois, told of her experiences with children who had reading difficulties. Social and physical maladjustments could often be traced to inability to read. She stressed the fact that every teacher should become more aware of the necessity for correction of minor difficulties which could be handled in the school room and the need for the help of the specialist in reading to correct the more serious difficulties.

THE SECTION MEETINGS

For the first time in the history of the Association, the members met in four groups: the elementary school; the junior high school; the senior high school; and the junior college. One would judge from the comments that the meetings were highly successful and ought to be continued in the future. The reports are not complete but any omissions will be published in later Journals.

THE JUNIOR HIGH SCHOOL SECTION

The meeting of the Junior High School section was called to order by the chairman, Theodore J. Kuemmerlein.

Dr. Morris Meister of New York talked on "Science Concepts to be Taught in the Junior High School." Because New York has just completed and adopted its new curriculum in junior high school science, Dr. Meister gave a detailed account of how it was built. He gave duplicates of the introduction to the course of study and the left hand column of the first three units. Other helpful material was given out in the examples of the Four Different Types of Teacher-Class (Learning) Activities. These teacher-class learning activities are: (1) "On Authority," (2) "Discussion," (3) "Visual Aids," and (4) "Evidence Gathering." At times it is valuable to know how much time a teacher should spend in each type in each grade.

Dr. Meister summarized in tabulated form the percentage of time spent using each method. The New York Curriculum embodies the following: (1) it is not specialized, (2) it integrates and correlates sequential ideas, (3) allows for leisure teaching (nine weeks on two units—air, water), (4) takes care of individual differences, (5) encourages straight thinking, and (6) helps the teacher.

The second topic was "A Program for Conservation Education in the Junior High School," given by Guy Barlow of Appleton, Wisconsin. Mr. Barlow like Dr. Meister presented those attending the section with the actual material for work on conservation. He gave out copies of the course used in junior and senior high school and showed how the English or Social Science teacher could make use of this material in his teaching. Mr. Barlow's talk was followed by pictures illustrating how the course of conservation functions in a school.

With only a few minutes left before the close of the session, Dr. J. S. Georges had only time enough to give the list of the concepts to be taught in junior high school mathematics. The discussion will appear in full in the magazine at a future date.

PAULINE ROYT, *Secretary*

THE SENIOR HIGH SCHOOL SECTION

Miss Lillian Bondurant, the chairman of the section, introduced the speakers.

"A Program in Science for All of the Pupils of the Senior High School" was discussed by Sherman R. Wilson.

The speaker, in his reported findings, attempted to analyze the needs and trends that are influencing the status of the sciences in the senior high schools of America. In his own city of Detroit he found the trend was away from certain science courses to such a noticeable degree that one was forced to make many queries—such as the one frequently noted—"Why is it so many pupils are taking courses other than physics?" A general survey of the Detroit schools revealed that many new subjects were being offered—and that such subjects as social studies were being very much popularized. Being well advertised with claimed advantages the social studies had made an inroad on the regular high school sciences both through their emphasis upon the necessity of being scientific and through their special methods of stressing problems of citizenship.

In Detroit it seemed advisable to offer Two-way Science Courses in the senior high schools. By following this plan a regular college preparatory course could be continued, while a second and more general course could be offered for pupils of non-college needs. This Two-way Science Course plan is now adopted and being used—and it has also been proposed for use in New York City.

Faced with this same problem in the suburban towns about Chicago it seems evident that at least four major conclusions have been reached:

1. There is a general need for modified high school science courses.
2. These courses should supplement but not replace the present courses.
3. These new courses should not be lacking in basic scientific principles.
4. That the ideal place for general science is in the elementary grades.

A need for changes is generally recognized but the exact changes have not always been agreed upon. Many kinds of integrations have been suggested. Some say that our present courses of chemistry and physics will be forced out of the high schools. Others say that they must stay but that we need more fundamental mathematics for our science courses.

In many places social phases are being stressed in science courses. Special courses have been developed offering greater vocational and edu-

cational guidance and giving greater general information of a cultural value. Descriptive chemistry and descriptive physics courses have been tried. In Detroit these have

1. Increased the interest in science.
2. Brought a greater enrollment in science courses.
3. Apparently filled a need that is general in that community.
4. Achieved enough vocational and educational guidance to definitely aid pupils in finding themselves.

From his findings in this study Dr. Wilson concluded that

1. Senior high schools should have four years of science.
2. A two-way program is needed in practically all senior high schools.
3. Many high schools can find it to their advantage to follow the same sequence through the four years.
4. Senior high schools in general prefer chemistry and physics as the two major high school subjects.

R. E. PARK

THE JUNIOR COLLEGE SECTION

The first meeting of the Junior College Group in the history of the Association was called to order November 26, 1938 at 10 A.M. by Dr. J. M. Kinney of Woodrow Wilson Junior College, Chicago, Illinois.

The nominating committee consisting of Dr. Glen W. Warner of Woodrow Wilson Junior College, Chicago, Dr. W. C. Krathwohl of Armour Institute and Mr. F. J. Breeze, Fort Wayne H. S., reported the choice of Mr. Louis R. Hull of the Fort Wayne High School and Indiana University Extension as chairman of the section for 1939. The report was accepted.

Mr. O. M. Miller, Woodrow Wilson Junior College, Chicago, was programmed to speak on the subject "The Desirability of the Understanding of Mathematical Concepts and Principles as a Preliminary Step to the Mastery of Manipulation and Technique" but was unable to attend. Dr. Kinney substituted for Mr. Miller by reading a portion of a paper by Professor E. A. Hedrick, University of California at Los Angeles. The subject was "The Function Concept in Elementary Teaching and in Advanced Mathematics." This paper emphasized functional thinking as the great central theme of mathematics and reviewed briefly the entry of the function concept into all mathematics, from the first steps of arithmetic to the more advanced treatment of the theory of functions as such.

The second speaker was Dr. H. I. Schlesinger, Professor of Chemistry, University of Chicago. His subject was "Some Aspects of Laboratory Work in General Chemistry." Dr. Schlesinger said that we should not separate students going on in chemistry from those taking chemistry as part of their general education. The most important end to be attained is the development of certain attitudes and habits of mind which are the same for both groups. If the college students of chemistry gets pleasure in seeing how the hypothesis is developed from theory and how it leads to facts this interest will train him in methods of thinking, working, drawing conclusions, and forming judgments. That judgments should be based on facts is the most important thing to give the student. Start the chemistry course on some central theme and hang onto it the facts in orderly arrangement. Let the students gradually learn techniques to the point where only the direction to prove or disprove something is necessary. Laboratory work by the student should supplement, not reinforce, experiments made by the instructor. Finally, give the student the desire to look into the foundations, not only of chemistry but of their own lives and society and to form considered, not emotional, judgments.

The third speaker was Mr. P. P. Dewitt, Hanly Junior High School, University City, Missouri. His subject was "Attitudes Related to the Study of College Science." Mr. Dewitt gave the report of an extensive investigation to determine whether different points of view were held by those having done four years of college work and those who had not. Two classes of college students were considered, those who had been science-trained and those who had not been science-trained. The scores of the non-science group in college were found to be between the scores of the science group in college and the non-college group. The science-trained college group was more international minded, more social minded, had greater beliefs in pacifism, had a more hopeful outlook, less prejudice, less conservatism, and was less religious minded than either of the other groups. His vocational likes, food likes, and activity likes were greatest and his dislikes the least.

The fourth speaker was Mr. R. Clark Gilmore, Wright Junior College, Chicago, Illinois. His subject was, "The Function of Biological Science in General Education." Mr. Gilmore said that the objectives of general education are personal health, worthy home membership, ethical character, training for citizenship, command of fundamental processes, vocation, worthy use of leisure. Then Mr. Gilmore showed how the study of biology contributed to these objectives, through subject matter, field trips, participation in experiments, demonstrations and scientific reading.

EDNA M. FELTGES, *Secretary*

Address by Dr. Christopherson, Professor of Mathematics and President of the National Council of Teachers of Mathematics given at the meeting of Central Association of Science and Mathematics Teachers, Saturday, November 26, 1938, at the LaSalle Hotel, Chicago, Illinois.

Some Mathematical Concepts to be Taught in the Tenth Grade

The aim of the talk was to impress upon teachers the importance of carrying geometric concepts over into non-geometric fields. There were three points discussed:

1. A review of the professed claims for geometry.
2. The analysis of a particular geometric exercise showing the characteristics of rigorous reasoning.
3. Applications of fundamentals of reasoning to non-geometric situations.

Dr. Christopherson quoted from several eminent authorities, one of his quotations being taken from the 1938 report of the Joint Commission—"To mathematize a subject means to mould and fuse it into a whole." Deductive reasoning was discussed.

The general characteristics of a proof were outlined into seven distinct points. The first of these points was the necessity for clear definitions of all terms, and its importance was illustrated in numerous situations other than those mathematical as were indeed, all seven of the salient points. One of the most interesting and impressive ways of illustration of rigorous reasoning was his continuous illustration by analyzing current events and their implications.

Another type of illustration was his throwing the searchlight of the geometric type of rigorous reasoning on modern methods of advertising and salesmanship.

The converses of statements and the line of reasoning used in indirect proof merits special attention for its application and use in non-geometric situations. Since converses are quite often not true—note converses of certain advertisements.

In summary, the purpose of the paper was to illustrate the need of geometric proof as a pattern for thinking in general situations, to show the need for definitions, and to show the dependence of conclusions on these definitions, assumptions, postulates, and previously proved statements.

The paper closed with an appeal to geometry teachers to point out to classes the geometric way of thinking in non-geometric situations.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1558. *C. R. Cassity, University of Alabama.*

1568. *Proposed by Cecil B. Read, University of Wichita, Kansas.*

Solve for x:

$$1+x^4=a(1+x)^4.$$

Solution by Walter R. Warne, 645 Erie St. E., Minneapolis, Minn.

(1) $$1+x^4=a(1+x)^4,$$

expanding the right member, collecting terms, one obtains

(2) $$(a-1)x^4+4ax^3+6ax^2+4ax+(a-1)=0,$$

a recurring equation.

Dividing (2) through $x^2(x\neq 0)$ and regrouping,

(3) $$(a-1)\left(x^2+\frac{1}{x^2}\right)+4a\left(x+\frac{1}{x}\right)+6a=0.$$

From (3), since

$$\left(x^2+\frac{1}{x^2}\right)=\left(x+\frac{1}{x}\right)^2-2,$$

$$(a-1)\left(x+\frac{1}{x}\right)^2+4a\left(x+\frac{1}{x}\right)+4a+2=0, \tag{4}$$

a quadratic in $x+(1/x)$, which can easily be solved. If $x+(1/x)=k_1$ and k_2, the four values of x are easily obtained.

Solutions were also offered by M. Kirk, West Chester, Pennsylvania and also by the Proposer.

1569. *Proposed by an algebra student.*

Solve for x:

$$\sqrt{x-\frac{1}{x}}+\sqrt{1-\frac{1}{x}}=\frac{x-1}{x}.$$

Solution by M. Kirk, West Chester, Pa.

$$\sqrt{x-\frac{1}{x}}+\sqrt{1-\frac{1}{x}}=\frac{x-1}{x}. \tag{1}$$

By squaring, collecting terms and squaring again, one obtains:

$$x^6-4x^5+4x^4+2x^3-4x^2+1=0. \tag{2}$$

By use of factor theorem, 1 is seen to be a double root of (2). Removing the factor $(x-1)^2$, the depressed equation is:

$$x^4-2x^3-x^2+2x+1=0. \tag{3}$$

By the transformation of $y=2x$.

$$y^4-4y^3-4y^2+16y+16=0. \tag{4}$$

Again using $z+1=y$,

$$z^4-10z^2+25=0. \tag{5}$$

From which

$$z^2=5 \text{ (twice)}, z=\pm\sqrt{5}, y=1\pm\sqrt{5}, \text{ and } x=\frac{1\pm\sqrt{5}}{2}.$$

The roots of (2) are therefore

$$\frac{1+\sqrt{5}}{2}, \frac{1+\sqrt{5}}{2}, \frac{1-\sqrt{5}}{2}, \frac{1-\sqrt{5}}{2}, 1 \text{ and } 1.$$

However the roots of (1) are $1, \frac{1\pm\sqrt{5}}{2}$.

Solutions were also offered by John F. Wagner, Lewis Institute, Chicago, Walter R. Warne, Minneapolis, Minn., also by the Proposer.

1570. *Proposed by Walter R. Warne, Minneapolis, Minn.*

If the base of a triangle AB is given and the opposite angle C, find the minimum value of $AC+BC$.

Solution by M. Kirk, West Chester, Pa.

By the law of sines.

$$AC=\frac{AB\sin B}{\sin C}. \tag{1}$$

$$BC=\frac{AB\sin A}{\sin C}. \tag{2}$$

$$\begin{aligned} AC+BC&=\frac{AB}{\sin C}(\sin A+\sin B) \\ &=\frac{AB}{\sin C}\left(2\sin\frac{A+B}{2}\cos\frac{A-B}{2}\right) \\ &=\left(\frac{AB}{\sin C}2\cos\frac{C}{2}\right)\cos\frac{A-B}{2} \\ &=(\text{a constant})\cos\frac{A-B}{2}, \end{aligned} \tag{3}$$

since AB and C are constants. Hence $AC+BC$ is a maximum when

$$\cos\frac{A-B}{2} \text{ is a maximum.}$$

This function is a maximum when $A=B$. Hence the triangle is isosceles; and therefore

$$\frac{AB}{2}=AC\sin\frac{C}{2}. \tag{4}$$

and

$$\frac{AB}{2}=BC\sin\frac{C}{2}. \tag{5}$$

Adding (4) and (5)

$$AB=(AC+BC)\sin\frac{C}{2} \text{ or}$$

$$AC+BC=AB\csc\frac{C}{2}.$$

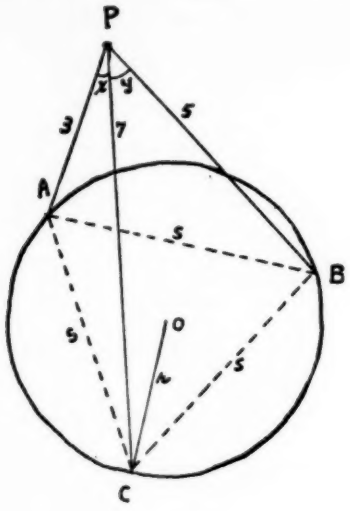
Solutions were also offered by Aaron Buchman, Buffalo, N. Y., Arthur Danzl, Collegeville, Minn., and the Proposer.

1571. *Proposed by Thomas A. Pickett, South Weymouth, Mass.*

Three towers, A, B, and C are situated at equal distances from each other on the circular walls enclosing a city. An outlying hill is 3 miles from A, 5 from B, and 7 from C. What is the diameter of the circle?

Solution by A. MacNeish, Chicago

Let $d=$ the diameter of the circle
$r=$ the radius
$x=\angle APC$



$y = \angle CPB$
$AP = 3$
$PB = 5$
$PC = 7$
$s = AB$, AC, and BC
$\triangle ABC$ is equilateral, therefore $s = r\sqrt{3}$.
Since P is an outlying point $\angle x + \angle y = \angle APB$.
By the law of cosines in $\triangle APC$,

$$\cos x = \frac{58 - 3r^2}{42}$$

in $\triangle CPB$,

$$\cos y = \frac{74 - 3r^2}{70}$$

in $\triangle APB$,

$$\cos (x+y) = \frac{34 - 3r^2}{30}$$

but

$$\cos (x+y) = \cos x \cos y - \sin x \sin y$$

and

$$\sin x = \sqrt{1 - \cos^2 x}, \quad \sin y = \sqrt{1 - \cos^2 y}$$

therefore by substitution

$$\frac{34 - 3r^2}{30} \quad \frac{58 - 3r^2}{42} \cdot \frac{74 - 3r^2}{70} - \sqrt{1 - \left(\frac{58 - 3r^2}{42}\right)^2} \cdot \sqrt{1 - \left(\frac{74 - 3r^2}{70}\right)^2}.$$

Squaring and simplifying

$$9r^4 - 249\, r^2 + 1216 = 0$$

$$r^2=\frac{249\pm135}{18}=\frac{384}{18}\text{ or }\frac{114}{18}$$

$$r^2=\frac{192}{9}\text{ or }\frac{57}{9}$$

$$r=4.6189\text{ or }2.5166$$

$$d=9.2378\text{ or }5.0332.$$

For the outlying point $d=5.0332$ miles.

Solutions were also offered by Walter R. Warne, Minneapolis, Minn., M. Kirk, West Chester, Pa., Thomas A. Pickett, South Weymouth, Mass., W. R. Smith, Chicago, Illinois.

1572. *Proposed by S. Ahmad Husain, Lucknow, India.*

Given an angle XOY, and a point P on the bisector of the angle; to draw a straight line CPD terminated by the arms in C and D, and of a given length l.

Solution by Proposer.

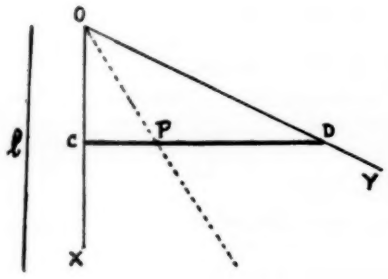


FIG. 1

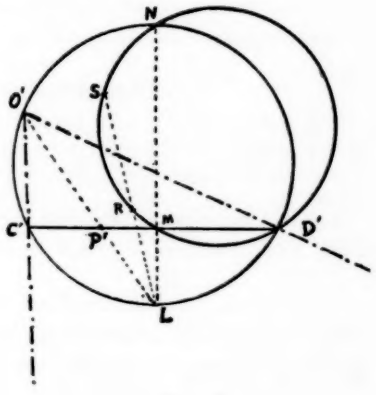


FIG. 2

In figure (2), take $C'D'=l$ and describe a circle containing an angle $=XOY$ in its segment. Draw LMN a diameter perpendicular to $C'D'$. Circumscribe a circle about NMD'. Through L draw a secant LRS so that $RS=OP$. Cut off $LP'=LR$ and produce it to meet the first circle at O'. It can easily be proved that $O'P'=SR=OP$. Join $O'C'$, $O'D'$. Then the required triangle OCD in figure (1) will be identical with $O'C'D'$ in figure (2).

Solutions were also offered by W. R. Warne, Minneapolis, and M. Kirk, West Chester, Pa.

1573. *Proposed by Edward C. Varnum, Clyde, Ohio*

In 1800 a man left a fund for three charities which was to be made available when the second charity has the greatest amount. The first charity receives a dollar at 6% compounded annually, the second gets one dollar the first year, two dollars the second year, three dollars the third year, etc., and the third charity is to have $1232 at 6% simple interest. When will the charities receive their money?

Solution by W. R. Smith, Chicago

At the end of n years the values of the three charities in dollars will be,

$$\text{First charity} = (1.06)^n$$

$$\text{Second charity} = \frac{n^2+n}{2}$$

$$\text{Third charity} = 1232(1+.06n).$$

Let x = no. of years when second and third charities will be equal.

$$\frac{x^2+x}{2} = 1232(1+.06x)$$

$$x = 162.5+.$$

At the end of 163 years the values would be

$$\text{First charity} = \$13354.+$$

$$\text{Second charity} = \$13366.+$$

$$\text{Third charity} = \$13324.+$$

The charities would receive their money January 1, 1963.

Solutions were also offered by M. Kirk and the proposer.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

1569. *Courtney Gardin and Vaughn Connor, Edison H.S., San Antonio, Texas.*

PROBLEMS FOR SOLUTION

1586. *Proposed by Claude M. Shepley, Minneapolis.*

Three circles each of radius r are tangent to each other externally at points A, B, C. If the area of the portion bounded by arcs AB, AC and BC is one-half acre, find the radius.

1587. *Proposed by Lester Dawson, College, Alaska.*

A circular cylindrical can which stands vertically is used to measure the amount of rainfall when rain is falling at an angle of 60° with the horizontal. What is the true rainfall if two inches were reported?

1589. *Proposed by Cecil B. Read, Wichita, Kansas.*

In a triangle ABC, angles B and C are each eighty degrees. CD is drawn, intersecting AB at D, such that angle $BCD = 50°$; BE intersects AC at E, making angle $CBE = 60°$. Find, by methods of plane geometry alone, angle DEB.

1589. *Proposed by O. F. McCrary, Raleigh, N. C.*

A man has 3 sons, ages 7, 14 and 21. He has \$1500 he wishes to divide among them. The 21-year-old son is given his part of the money. The 14-year-old son's part is put in the bank to draw interest at 6% compounded annually until he is 21 years of age. The 7-year-old son's part is also deposited in the bank at 6%, and compounded annually until he is 21. When each one has received his money they will each have the same amount. How is the \$1500 divided?

1590. *Proposed by William W. Taylor, Port Arthur, Texas.*

Construct a triangle, given the circumradius, the base, and the ratio of the altitudes to the other two sides.

1591. *Proposed by Walter R. Warne, Minneapolis.*

Solve the system

$$x^3+y(xy-1)=0.$$
$$y^5-x(xy+1)=0.$$

SCIENCE QUESTIONS

January, 1939
Conducted by Franklin T. Jones

IMPORTANT QUESTIONS

What do you want in this Department?
(Tell the Editor and he will do his best.)
Should questions be aimed—
For Class Use?
For the Teacher?
For the General Reader?
Send in your "Do you know the Answer" Questions.

Questions for discussion, examination papers, disputed points may be submitted to this department. They will be published together with discussion.

Please let us know what you are working on. It will be helpful to pass the information along.

Send all communications to my home address—Franklin T. Jones, 10109 Wilbur Ave., S.E., Cleveland, Ohio.

DO YOU KNOW THE ANSWERS?

Contributors are requested to propose short, snappy questions for this section of ***Science Questions.***

(*Continued from October, November and December, 1938.*)

21. Why does a car "skid" on wet pavement?
22. Why do telegraph wires "sing" in a winter wind?
23. Is there such a thing as a dress-suit made out of rubber?
24. Have you tried raising plants by "soilless culture"?
25. Which is more poisonous "prussic acid" or "nicotine"?

ANSWERS

For "Do You Know the Answers" of November, 1938

11. The first submarine was devised by David Bushnell, a Connecticut Yankee who graduated from Yale. This "sub" was called "TheTurtle" and was used against the British man-of-war "Eagle" in Boston Harbor during the Revolutionary War. The pilot was Sergt. Ezra Lee. Lee and the "Eagle" both escaped harm.
12. Jules Verne wrote *Twenty-Thousand Leagues under the Sea* and *Mysterious Island* both introducing the *Nautilus—a Submarine.* The equipment included electric lights.
13. The patron saint of Alchemists was Albertus Magnus.

14. "Driving in darkness with headlights turned on." "If, for instance, the effective range of your headlights is 200 feet and you are travelling more than 45 m.p.h., it will be very difficult for you to stop within the distance you can see." This is "outdriving your lights" and by the excess of the necessary stopping distance over the range of your headlights, you are driving in the darkness.
15. Send in your "interesting or instruction question."

GQRA—NEW MEMBERS—JANUARY, 1939

255. H. Emmett Brown, Teacher of Science, Lincoln School of Teachers College, and Instructor in Teaching of Natural Sciences. Teachers College, Columbia University.
256. Marcella Dornex, Mercy High School, Milwaukee, Wis.

TEST IN SOUND

850. *Proposed by H. Emmett Brown (Elected to the GQRA, No. 255), Science Department, Lincoln School, Teachers College, Columbia University.*

Comments are desired

Items 1–18 are true-false items. Place a plus (+) sign in the space provided at the right if true; a zero (0) if false.

1. When 10 beats per second result from the combination of two sounds then there are 10 occasions during a second when the sounds reenforce each other and, always and inevitably, 10 occasions when the sounds interfere with each other.... ( ) 1.
2. In the even-tempered scale, the ratio between the vibration rates of the higher and the lower of any two adjoining notes is the same..... ( ) 2.
3. With closed pipes, the first resonant length is $\frac{1}{2}$ the wave length of the note to which they resonate most strongly, if any correction for diameter is neglected..... ( ) 3.
4. In a given homogeneous medium, the velocity of a given note equals its wave length multiplied by its frequency... ( ) 4.
5. On the moon, sound would travel more rapidly than on earth..... ( ) 5.
6. Only those sounds whose waves may be represented by smooth curves are musical..... ( ) 6.
7. $600/6 = 2$ bels..... ( ) 7.
8. The even-tempered scale was developed because it is generally more pleasing to the ear than the diatonic..... ( ) 8.
9. Reenforcement of a given sound takes place only when the reenforcing object vibrates sympathetically with the fundamental of the sound..... ( ) 9.
10. In a given homogeneous medium, the frequency of a given note is directly proportional to its wave length..... ( ) 10.
11. It is possible to measure the energy that a given sound wave contains in work units..... ( ) 11.
12. It is impossible for an object to produce sound if it is not vibrating..... ( ) 12.
13. $50/4 = 11$ decibels..... ( ) 13.
14. A person singing unaccompanied would be more likely to sing in the even-tempered scale than in the diatonic scale.. ( ) 14.
15. Reverberation is the result of distinct echoes in an auditorium..... ( ) 15.
16. It is possible for two sounds so to unite as to produce silence ( ) 16.

17. Disregarding the correction for diameter, a closed pipe 3 feet long resonates most strongly to a note whose wave length is 12 feet..... ( ) 17.
18. A sound containing 5 bels more energy than another sound has 10,000 times as much energy as the second sound..... ( ) 18.

Items 19–26 are completion items. Place the answer in the space provided at the right of the item.

19. In devising the even-tempered scale, the one thing preserved from the diatonic scale, was the interval between the notes forming a(n) 19. _____ 19.
20. Two strings under the same tension and of the same material and diameter produce the notes C (256 v.p.s.) and E (320 v.p.s.). If the latter string (E) is 100 cm. long, the other string is (20) cm. long. _____ 20.
21. A certain string, 100 cm. long, and under a tension of 5 lbs. produces the note G (384 v.p.s.) when plucked. It will resonate most strongly to a sound whose vibration frequency is (21) v.p.s. _____ 21.
22. The speed of sound in air at 25°C is (22) ft./sec. _____ 22.
23. On a day when the speed of sound in air is 1120 ft./sec., the frequency of a fork which produces a note whose wave length in air is 8 feet, is (23). _____ 23.
24. A sound is produced only when a material object is caused to (24). _____ 24.
25. Poor sound conditions in a room are usually due to excessive amount of (25.) _____ 25.
26. Under laboratory conditions, persons of normal hearing ability would be able to distinguish (26) (how many?) levels of loudness between two sounds of the same pitch and quality, one of which has 100 times as much energy as the other? _____ 26.

In items 27–35, place the letters to indicate the *two* choices which are most closely associated with the word in capitals at the beginning of the item, in the spaces provided at the right of the item. No credit unless *both* spaces are correct. The order of answers is of no importance.

27. PERIODIC (a) regular (b) noise (c) explosion (d) area (e) music ___ & ___ 27.
28. ACOUSTICS (a) one second (b) velocity (c) wave length (d) reverberation (e) five seconds ___ & ___ 28.
29. BEATS (a) same (b) velocity (c) difference (d) frequency (e) amplitude (f) drum ___ & ___ 29.
30. FREQUENCY (a) direct (b) length (c) inversely (d) quality (e) amplitude ___ & ___ 30.
31. EVEN-TEMPERED (a) 2:1 (b) 4:1 (c) 4:5:6 (d) $2\sqrt{12}$ (e) $\sqrt[12]{2}$ (f) $\sqrt[6]{2}$ ___ & ___ 31.
32. PITCH (a) speed (b) velocity (c) number (d) focus (e) amplitude (f) vibrations ___ & ___ 32.
33. BEATS (a) interference (b) velocity (c) amplitude (d) quality (e) reenforcement ___ & ___ 33.
34. DIATONIC (a) 2:3:4 (b) 4:5:6 (c) 6:7:8 (d) 2:1 (e) 4:1 ___ & ___ 34.

35. DISCORD (a) quality (b) overtones (c) 1000 (d) beats (e) pitch (f) 32 (g) interval (h) $\frac{1}{4}$ (i) $\frac{1}{2}$ (j) $\frac{3}{4}$ ___ & ___ 35.

(This test to be concluded in February.)

BURSTING THE CASK AT BROOKLINE

851. *Proposed by John C. Packard (GQRA No. 1), Brookline High School, Brookline, Mass.*

Pascal's Experiment of the "bursting of a cask" by hydrostatic pressure is often illustrated by the picture of a man climbing a ladder and pouring water from a pitcher into a long tube inserted in the head of the cask.

Query.—How high must the man climb if the hydrostatic pressure of the column of water is to burst the cask? Would the cask give way at the staves or at the head next the ground? Has anyone tried it?

As a mode of recognizing contributors, the Guild of Question Raisers and Answerers (GQRA) has been formed and 256 contributors have already been admitted to Membership. Classes or individuals, may become members by proposing a question or submitting an answer.

JOIN THE GQRA

A NOTE ON THE RELATIONSHIP OF MARKS IN COLLEGE COURSES WITH HIGH SCHOOL COURSES

BY CECIL B. READ
Municipal University of Wichita, Wichita, Kansas

In an article in the October 1938 SCHOOL SCIENCE AND MATHEMATICS (Vol. 38, pp. 743–746) certain conclusions are drawn regarding the relationship of high school and college marks in physics. Perhaps these conclusions should be analyzed.

Obviously the second order correlations quoted do not eliminate all other factors but only those factors measured in the study. However without seeming to quibble over details I should like to point out certain conclusions which seem to me to be not completely justified by the evidence available.

The number of cases involved was not stated but apparently, to judge by the probable errors of the zero order coefficients of correlation, the number of cases was less than one hundred. (The first coefficient quoted as $.77 \pm .33$ is an obvious misprint.) Likewise it is impossible to check the first order correlations; since zero order correlations are given separately for algebra and geometry, while the partial correlations apparently combine these courses as mathematics.

If we assume one hundred cases, the second order correlations of general physics with high school physics and with intelligence would have probable errors of .035 and .028, respectively. The probable error of the difference would be .045. Certainly we lack sufficient evidence for interpretation 2, that the influence of intelligence on success in college physics is higher than that of high school physics for the difference is less than twice its probable error.

From the point of view of the mathematics teachers, I am disturbed by the statement regarding the comparatively insignificant effect of high school mathematics. (Incidentally, in another place the article admits the figure quoted may be too low.) Why were the partial correlations of the first order in which high school mathematics is held constant not quoted?

Unless there is a misprint, I believe there is a discrepancy somewhere, for if the second order correlation between general physics and high school mathematics is computed by use of the first three first order correlations listed in the table, a value of .44 is obtained. This, while not high, is far from a negligible relationship. The actual relationship may be negligible, but I desire more evidence before I shall admit this to be the case. Are not more than one hundred cases needed for a valid use of partial correlation?

REPLY

By C. A. Foster

I am in complete agreement with the statement that all factors having contribution to college marks are not eliminated. I believe that such a statement is made in the article in question.

The statement in the third paragraph of the note is also correct. The coefficient quoted should be $.77 \pm .033$. However with regard to the second observation in this paragraph I will say that the evident lack of significant difference between the correlations for algebra and geometry makes it appear that there will be no material error in combining them.

I will also agree with the criticism given in paragraph four. A better statement would be to combine conclusions one and two in a single statement that the influence of both high school physics and native intelligence seem to be high. There was no intention of assuming that the one is particularly higher than the other.

Referring to paragraph five, I do not believe that there is reason for particular alarm on the part of mathematics teachers. It seems to me that the study would show, if it shows anything, that some factors making for high grades in mathematics make also for high grades in college physics. I might mention parenthetically that a similar study for college chemistry, the figures for which are not quoted in my article, show a similarly low coefficient for chemistry and mathematics. I should like also in this connection to call attention to the limited nature of this investigation as to type of school, number of schools, number of cases, etc.

There is an oversight, in the failure to include the first order correlations. Also I note that two correlations were left out of the zero-order list. I quote them here.

Zero order:

H. S. physics—H. S. Mathematics 123 cases	P. E. .034	.66
H. S. mathematics—I. Q. 112 cases	P. E. .048	.49

First order:

H. S. physics—college physics math. constant	.53
College physics—I. Q. math. constant	.61
H. S. physics—I. Q. math. constant	.16

Referring to the last paragraph again I agree that too few cases are involved here (although there are a few more than a hundred) to make sweeping conclusions. I believe, however, I have refrained from making such conclusions as will be seen if the article is read in its entirety.

BOOKS AND PAMPHLETS RECEIVED

Introductory Mathematical Analysis, by Joel S. Georges, Chairman of Department of Mathematics, Wright Junior College, Chicago, Illinois, and Jacob M. Kinney, Chairman of Department of Mathematics, Woodrow Wilson Junior College, Chicago, Illinois. Cloth. Pages xv+605. 14.5 ×23 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.00.

Household Physics, by Madalyn Avery, Assistant Professor of Physics, Kansas State College of Agriculture and Applied Science. Cloth. Pages xv+439. 13.5×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $3.50.

The Structure of Economic Plants, by Herman E. Hayward, Professor of Botany, The University of Chicago. Cloth. Pages x+674. 15×23.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.90.

Physical Geography and Geology, by L. Dudley Stamp, Sometime Professor of Geology and Geography in the University of Rangoon, Cassel Reader in the University of London. Cloth. Pages vii+256. 12×18.5 cm. 1938. Longmans, Green and Company, 114 Fifth Avenue, New York, N. Y. Price $1.75.

Animals Without Backbones, by Ralph Buchsbaum, Department of Zoology, The University of Chicago. Cloth. Pages ix+371. 16.5×23 cm. 1938. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price $3.75.

Physics Made Easy, by Louis T. Masson, Bachelor of Science, Master of Education Riverside High School, Buffalo, New York, and Edited by Jean F. Piccard, Doctor of Natural Science, Professor of Aeronautical Engineering, University of Minnesota. Cloth. 384 pages. 13×19 cm. 1938. W. Hazleton Smith, Educational Publishers, 37 Franklin Street, Buffalo, N.Y.

The Perception of Light, by W. D. Wright, Lecturer in Physics, Imperial College of Science and Technology Consultant Physicist, Electric and Musical Industries, Ltd. Cloth. 100 pages. 12. 18.5 cm. 1938. Blackie and Son Ltd., 17 Stanhope Street, Glasgow, Scotland C. 4. Price 6s. net.

Grammar for Everyday Use, by Helen Fern Daringer, The Lincoln School of Teachers College, Columbia University. Cloth. pages x+338. 12.5×19 cm. 1938. World Book Company, Yonkers-on-Hudson, New York, N. Y. Price $1.00.

An Introduction to Laboratory Technique, by A. J. Ansley, Physics Department, University College of the South-West of England, Exter. Cloth. Pages xiii+313. 13.5×22 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

Coordinate Solid Geometry, by Robert J. T. Bell, Professor of Mathematics in the University of Otago, Dunedin, N. Z., Formerly Lecturer in

Mathematics in the University of Glasgow. Cloth. Pages xiii+175+xliii. 14×22 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.25.

Theoretical Mechanics, by Carl Jenness Coe, Assistant Professor of Mathematics, The University of Michigan. Cloth. Pages xiii+555. 14×21.5 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $5.00.

Fundamental Electronics and Vacuum Tubes, by Arthur Lemuel Albert, Professor of Communication Engineering, Oregon State College. Cloth. Pages ix+422. 14×23 cm. 1938. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

The Chemical Organization of Living Matter, by C. F. Krafft. Second Edition. Paper. 29 pages. 15×23 cm. 1938. C. F. Krafft, 2510 Q Street, N. W., Washington, D. C.

The Nervous System, A Guide for Use with the Educational Sound Picture "The Nervous System," prepared by James A. Brill, Director of Production, Erpi Classroom Films, Inc. in Collaboration with Frederick T. Howard, Advanced School of Education, Teachers College, Columbia University, and Ralph W. Gerard, The University of Chicago. Paper. Pages iv+30. 13.5×20 cm. 1938. The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill. Price 15 cents.

The High-School Science Library for 1937–1938, by Hanor A. Webb. Paper. Reprinted from Peabody Journal of Education, Vol. 16, No. 2, September, 1938. 17 pages. 17×24 cm. Hanor A. Webb, George Peabody College for Teachers, Nashville, Tenn.

A Survey of Courses of Study and Other Curriculum Materials Published Since 1934, by Bernice E. Leary, Senior Specialist in Elementary Education. Paper. Bulletin, 1937, No. 31. Pages v+185. 13.5×23 cm. United States Department of the Interior, Office of Education, Washington, D. C. Price 20 cents.

The Federal Government and Education, prepared by The Advisory Committee on Education. Paper. 31 pages. 15×23 cm. Advisory Committee on Education, North Interior Building, Washington, D. C.

Suggestions for Teaching Clear Thinking, prepared by Leroy H. Schnell, State Teachers College, Indiana, Pennsylvania. Paper. 11 pages. 15×23 cm. 1938. Harper and Brothers, 49 East 33rd Street, New York, N. Y.

ERRATUM: In the October, 1938, issue the *Review of Plane Geometry and Its Reasoning* by Barber and Hendrix gave the price $2.00. It should have been listed at $1.40.

BOOK REVIEWS

The reviews in this issue were written by Lyle F. Stewart, Zoology Editor; W. A. Porter, Science Demonstrations Editor; Druley Parker, Shortridge High School, Indianapolis, who is in charge of the Chemistry editorial office during the illness of Editor Wade; Walter H. Carnahan, Head of the Department of Mathematics, Shortridge High School, Indianapolis; and the following members of the Mathematics faculty of the George Washing-

ton High School, Indianapolis: O. W. Nicely, Ross T. Campbell, Lillian C. Neimann, H. Glenn Ludlow, and R. H. Jones.

High School Teachers' Methods, by Charles Elmer Holley, Ph.D. Cloth. Pages vii+514. 22×14.5 cm. 1937. The Garrard Press, Publishers, Champaign, Illinois. Price $3.00.

The teacher is constantly confronted with many problems the solution of which require different educational methods and techniques. A clear understanding of the principles underlying the various procedures tends to facilitate their correct use. In this volume Dr. Holley has sifted, from a large accumulation of material, the outstanding educational problems, methods and techniques. The relation of the different procedures to the principles and various philosophies of education is pointed out in a clear-cut and very understandable manner. The historical development of each procedure and principle is effectively used as a background for interpreting their relation to present-day classroom situations.

The text is divided into twenty seven chapters. General pre-tests are used to introduce each chapter; specific review questions along with suggested readings are placed at the end. Some of the important topics included in this book are: classroom management, motivation, favorable conditions for learning, the assignment, questioning, providing for individual differences, the development lesson, Morrison teaching cycle for science units, problem solving, group-study plan, individualized instruction (contract plan), the socialized recitation, the project method, development of desirable types of pupil individuality, measuring the results of teaching.

This volume is admirably suited not only for methods courses but also as a reference and source book for experienced as well as inexperienced teachers.

LYLE F. STEWART

The Magic Wand of Science, by Eugene W. Nelson. Cloth. Pages 213, 13.5×20 cm. 1938. E. P. Dutton & Company, Inc., New York, New York. Price, $2.00.

This little volume certainly has a place in every school library. It was written for the purpose of acquainting young people with the achievements of scientific research, and the problems raised by these advances. In achieving this purpose, the author briefly treats thirty of the more important phases or fields of scientific development. The book is well within the level of the secondary school pupils, and is supplied with illustrations of a nature too seldom found in books of this type.

The articles dealing with the historical development of the microscope, systems of weights, and the measurement of heat, were especially interesting to the reviewer.

The book gives adequate and authentic information about many topics which are of current interest. At times, one might wish that the subjects could be treated more specifically and in greater detail, but that again would perhaps defeat the original aim of the author.

W. A. PORTER

Laboratory Experiments in Elementary Physics, by Newton Henry Block, Assistant Professor of Physics, Harvard University. Cloth. Pages xiii +263. 14.5×21 cm. 1938. The Macmillan Company, New York, New York. Price $1.24.

This manual, bound as it is in book form, will be welcomed by those teachers who do not subscribe to the workbook technique in laboratory physics. The writer, a renowned and established author of physics texts

and manuals, recognizes the difficulty of constructing a manual that will adequatly fit a wide variety of teaching situations and personalities. In attempting to solve this problem, he has adhered rather closely to the usual Unit Arrangement, grouping his exercises under the following heading:

1. Measurement. Simple Machine Elements
2. Mechanics of Fluids. Properties of Matter
3. Forces and Motions
4. Heat Energy
5. Fundamentals of Magnetism and Electricity
6. Effects of an Electric Current
7. Sound Waves and Music
8. Light Waves and Their Uses
9. Radio and Radium

The manual lists sixty-two exercises of which thirty are starred as basic or fundamental in nature. Of the remaining thirty-two, fifteen are listed as supplementary, requiring more expensive and elaborate equipment. Each exercise begins with a statement of problem, which is followed by a list of apparatus required, an explanatory introduction, a set of directions or methods of procedure, an illustration, and a suggested tabulation of results.

The book is sound pedagogically, clearly and attractively illustrated, and is adequately supplied with tables of pertinent physical data.

W. A. PORTER

Chemical Arithmetic, by F. W. Goddard, M.A., F.C.S., Senior Science Master, The College, Winchester. Cloth. Pages vii+99. 13×19 cm. 1937. Longmans, Green & Co., New York.

The author states in the preface "This small book deals with the arithmetical aspect of elementary chemistry up to School Certificate standard. The principles involved are briefly explained, typical examples are worked out, and there are about 300 questions, all numerical, mostly taken from recent School Certificate papers set by the various examining boards. I think that it is generally admitted by teachers that the supply of numerical questions, in readily accessible form, is rather inadequate, and yet such questions are most useful when setting out of school work. It is hoped that this small volume will supply this need." What a Britisher means by "setting out of school work" is beyond the reviewer. Problems are included on Conservation of Mass, Definite Proportions, Gas Laws, Solubilities, Equivalents, Combination by Weight, Atomic Weights, Combination by Volume, Chemical Equations and Volumetric Analysis.

This book could be used as source material for a high school or college teacher. A student who wished to prepare for college entrance exams would find it useful, also. If a teacher had enough of these on hand for a whole class, they could be distributed during a class period, and a problem-solving session could be engaged in at regular intervals. Answers to the problems are included, as is also a table of logarithms.

One would have to "temper the wind to the shorn lamb" in the case of the average high school class. One notes with displeasure that the gas law problems are solved by the use of formulas.

DRULEY PARKER

An Introduction to Chemistry, by John C. Hogg, M.C., M.A., Chairman of the Department of Science, The Phillips Exeter Academy. Cloth. Pages 365. 22×15 cm. 1938. Oxford University Press.

Here is a book which is really different. The author states "Introduction to Chemistry stresses the historical approach," and examination shows

that the author accomplishes his goal. Numerous illustrations of the early chemists, alchemical laboratories and historical apparatus aid in the historical development.

The author has completely broken from the usual text by omitting a study of the metals, atomic structure, periodic table, ionization and chemical equilibrium. The Law of Definite Proportions and the Law of Multiple Proportions are taken up in the last chapter but one. Appendix I relates to heat and Appendix II relates to the etymology of chemical terms. Directions for numerous demonstration experiments are included in the textual material.

One wonders if this book is not the result of a feeling of the author and experienced by many teachers, that our pupils are suffering from a mental indigestion caused by gorging them with chemical information, rather than feeding them more sanely with chemical education. This book merits the attention and thought of every "dissatisfied" chemistry teacher.

DRULEY PARKER

A New Geometry, by A. W. Siddons, late fellow of Jesus College, Cambridge, England, and K. S. Snell, late scholar of Trinity College, Cambridge. 1938. Pp. xiv+302. Cambridge: at The University Press; New York: The Macmillan Company. Price $1.32.

This book is based upon the geometries of Godfrey and Siddons. Prepared for use in the schools of Great Britain, it is now offered for use in schools here. Quite naturally, the sequence and treatment of topics is very different from that to which American teachers are accustomed. In this book, much is assumed regarding previous geometric experience that is more fully developed in our books.

The first 231 pages of the book are organized to build up power of reasoning, the pupil being allowed to think things out without much emphasis on a logical system. Then in the last 69 pages is presented a Systematic Course where the logical sequence is given careful consideration. Ideas of solid geometry are freely introduced throughout the book, Chapter 4 being given wholly to three dimensional geometry. Topics from modern geometry are extensively treated. The language of the book is naturally different in some details from that of American texts. For example, "a line stands on another line," a "rider," "data which fix a triangle."

WALTER H. CARNAHAN

The Nature of Proof, by Harold P. Fawcett. Pages xi+146. 1938. Bureau of Publications, Teachers College, Columbia University, New York. Price $1.75.

This is the *Thirteenth Yearbook* of the National Council of Teachers of Mathematics. Impressed by the many demands being made that demonstrative geometry fulfil its avowed purpose of training pupils to think, Dr. Fawcett conducted an experimental class to try to determine whether this could be done in a better way than the conventional class in geometry. Pupils in his class had no text and no planned course. They built their own list of words to be used, worked out and agreed upon their definitions, and made another list of words to be accepted without formal definitions. Then they investigated geometric relations of lines, stated and proved their own theorems, and decided upon other theorems to be accepted without proof. In this way they actually built their own course in geometry. They attacked problems in non-geometric situations in the same manner and reasoned through them systematically. The book gives a full

account of the experiment. It is one of the really significant books of the year for teachers of mathematics.

WALTER H. CARNAHAN

Excursion in Mathematics, by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics and Head of the Department of Mathef matics, The University High School, The University of Chicago. 47 pages. 1938. The Orthovis Company, Chicago. Price $1.20.

This book of colored pictures, drawings and brief descriptions and discussions of the solid geometry figures, shows the uses of the solids and how to use the related formulas. By means of an Orthoscope, which comes with the book, the colored pictures are shown in three dimensions. This makes it possible for the pupil to gain an accurate idea of the appearance of the solids and the relations of their parts. The book should be very useful in General Mathematics and in Solid Geometry for giving a clear conception of the nature of the figures being studied.

WALTER H. CARNAHAN

Algebra for Today, Second Course, by William Betz, Vice-Principal of East High School and Specialist in mathematics for the public schools of Rochester, New York. New edition. 1938. Pages xii+518. Ginn and Company, New York. Price $1.36.

The author has written this second course with a minimum of assumptions regarding the number of principles which the pupil has retained from beginning algebra and the degree of his comprehension. The first part of such a text usually gives a review of the first year's work, but in *Algebra for Today* all subjects are developed fully and progress is very gradual. Motivating discussions to stimulate interest in algebra are frequent. The author has limited the number of topics treated and has given full treatment of those topics included. There is an unusually full treatment of logarithms and the slide rule. The subject of series is introduced and given an elementary treatment. At the end of the book there is a complete summary and review of the course. There are chapter tests but no diagnostic tests to determine how much the pupil has retained from previous study. The pupil gets some experience with the ideas of analytic geometry through the study of slopes, parabolas, hyperbolas, etc. A study of maxima and minima introduces some of the ideas of the calculus.

WALTER H. CARNAHAN

Plane Trigonometry, by George M. Hayes, Assistant Professor of Mathematics, College of the City of New York, and Murray J. Leventhal, Chairman Mathematics Department, James Madison High School, Brooklyn, New York. First edition. Cloth. 1938. Pages vii+248. Globe Book Company, New York. Price $1.60.

This is a very much simplified trigonometry carefully written to insure understanding of every idea presented. The authors spare no pains to develop every topic presented from the simplest fundamentals through the essential steps. To follow this method in a comparatively brief text necessarily means that the number of topics must be somewhat restricted or introduced for only a brief study. The exercises are for the most part well within the abilities of students who elect trigonometry, but many lists have honor problems to challenge better students. There are many review lists of problems to insure that ideas once learned are not forgotten.

The student is introduced to a number of instruments other than the transit. There is a full discussion of approximate measurement and significant digits. The slide rule is very briefly introduced. Logarithms are

introduced before the general solution of triangles so that the student will get ample practice in their use. Equations and identities and inverse functions are introduced rather late in the course. Polar coördinates and DeMoivre's Theorem are treated but not extensively.

The tables are very brief, the logarithmic tables being four place tables on two pages. Natural and logarithmic functions of the angles are for every ten minutes of arc. There are no answers to the problems. The book closes with a number of specimen examinations.

WALTER H. CARNAHAN

Review Course in Algebra, by W. E. Sewell, Assistant Professor in Mathematics, Georgia School of Technology. First edition. Cloth. Pages v+145. 15×20 cm. 1938. D. C. Heath and Company, Chicago. Price $1.20.

The author has observed that many students entering college have forgotten many facts and have lost much of the skill they once acquired and go on handicapped because of these losses. He has attempted to provide a book to be used as an instrument in restoring their lost knowledge and skills. The book is suitable for a review semester in high school or college. It is not merely an exercise book, but presents sufficient discussion and development to help pupils recall and understand principles which they may have known imperfectly or may have forgotten. The first seven chapters through systems of quadratic equations must be taken in order, but the last four chapters can be taken in any order. The first four chapters treat of ratio and proportion, variation, progressions, functions and graphs and the binomial theorem. The book closes with a set of review exercises.

Exercises in each list are graded for difficulty and become hard rather rapidly as one proceeds through the lists. If the book is used in high school classes, it is probable that many pupils will find many of the problems beyond easy solution unless the class is made up only of the better pupils, or unless the instructor moves very slowly and gives much help. In fact, the book is as much an extension as a review of previous courses. There are some word problems, but addition of others might improve the book. Mastery of this book would much improve any student's chances of success in further mathematics.

WALTER H. CARNAHAN

A Preface to Mathematics, by C. E. Van Horn, Professor of Mathematics, Fisk University. Cloth. Pages xii+124. Chapman and Grimes, Inc., Boston.

The author's purpose in writing this very brief textbook is threefold. First, to supply background and reasons for teaching mathematics to college and normal school classes. Second, to serve as supplemental handbook. Third, as an examination manual for seniors.

This new text contains twelve brief chapters on such topics as: Why study mathematics?—What is mathematics?—Pure Geometry—Trigonometry—Analytic Geometry—The Concept of a Function—The Calculus.

The organization is different from the traditional text. The expositions, illustrations and exercises are of particular value to the would-be teacher as well as the teacher in service. Historical references are scattered throughout the text to associate the subject matter with its historical background. The book is clearly written, well arranged, and logically organized although very technical in regard to the calculus.

O. W. NICELY

Solid Mensuration, by Willis F. Kern, Assistant Professor of Mathematics at the U. S. Naval Academy; and James R. Bland, Assistant Professor of Mathematics at the U. S. Naval Academy. Second edition. Pages vii+172. 14×22 cm. Cloth. 1938. John Wiley and Sons, Inc., New York. Price $2.00.

This book on *Solid Mensuration* gives a unique treatment of the theorems on volume, basing most of the analyses of these theorems on Cavalieri's theorem. This method is very effective and readily understandable as it is presented here and makes the whole subject of *Solid Mensuration* a more concise and comprehensive unit. The text gives intensive training in space intuition and the illustrations have been carefully selected and arranged to help the student gradually to visualize relationships of lines and planes until he can fully understand diagrams representing three-dimensional space forms. The drawings have been supplemented with halftone engravings wherever the student might have difficulty.

There are numerous exercises, carefully selected to stimulate the student's imagination and illustrate the usefulness and practical values of the subject. The formulas developed in this text are used extensively in construction and railway engineering and the problems have been selected to stress the practical phases.

The four place table of logarithms is unique in that it includes special tables of proportional parts, which permit greater speed and accuracy. In each list of problems there are some starred exercises requiring the use of trigonometry in their solution.

The purpose of the text, as stated by the authors, is "to present the fundamental, practical essentials of Solid Geometry in a new and concise but comprehensive manner," and they seem to have accomplished their purpose.

ROSS T. CAMPBELL

Mathematics: General Course, by Arthur E. Newton, Superintendent of Schools, Baldwin, Long Island, New York, and formerly Head of Mathematics Department, Utica Free Academy, Utica, New York. Cloth. Pages iii+462. 12.5×18.5 cm. 1938. Ginn and Company. Price $1.36.

There seems to be a definite agreement as to the basic subject matter which should be included in an accepted text book which will meet the requirements of an integrated course in high school mathematics. These requirements have been fully met with in the text under consideration. In arithmetic not only is ample material provided to insure a certain degree of skill and mastery of the fundamental operations with integers, fractions, and decimals, but a conscious effort has been made to fulfill the demand for socialized mathematics by constantly emphasizing the "social uses" of arithmetic. In respect to the algebra, geometry, and trigonometry no great departure has been made, other than more demonstrative geometry is given than is often the case. Adequate tables are included in the appendix of the book.

More important than the subject matter itself is its treatment. The text clearly proves that the author is thoroughly familiar with what are considered to be sound pedagogical principles. In this volume he has likewise been successful in accomplishing his aims as expressed in the preface; namely in emphasizing "the significance of mathematics from the students' point of view" and in "developing topics, wherever possible, by the use of familiar experiences." An excellent example of this is found in developing the understanding of a theorem by determining the hypothesis and conclusion of statements taken from common, everyday usage.

Throughout the book the explanations are exceptionally clear and well adapted to the age and understanding of the pupils. An effort has been made to interest and challenge the better students by introducing topics under the caption of "Interesting Things to Do" and by inserting many instructive notes of mathematical biography and history. The illustrations, though not too numerous, are well chosen with respect to their appeal and instructional value to the high school boy and girl. Also the various levels of ability of these pupils have been taken into consideration by the provision, not only of optional topics, but of many graded problems and exercises. The large number of oral and written exercises constitutes one of the merits of this work.

A degree of unity throughout the book has been achieved by the use of two kinds of tests or reviews found at the end of each chapter; first, a review of the immediate chapter, and then a cumulative review. With the introduction of new material in each chapter a connective link has been formed by a well planned review which correlates the new matter with that studied in one or more of the preceding chapters. For example, the intuitive geometry is reviewed in the detailed study of the theorem, and both, in turn, are reviewed again with the fuller development of formal demonstrative geometry. In short, the present text book compares very favorably with many other texts reviewed.

LILLIAN C. NEIMANN

Plane Geometry, by George F. Major, Instructor in The Phillips Exeter Academy, Andover, Massachusetts. First edition. 1938. Pages xv+280. 8 illustrations. Cloth. Charles Scribner's Sons, 597 Fifth Avenue, New York.

The dominant purpose of this new geometry text is to develop clear thinking, transferable to non-mathematical situations. The author claims that this textbook does teach students to think; that seven year's testing has proved it. The "laboratory method," sometimes called the "learning by doing" method, is used almost exclusively throughout the book. Stimulating questions and experiments lead the pupil to the formation and discovery of the theorems. Very few propositions are written out, as in the usual geometry text.

The idea of "Books" is abolished. Instead, the subject matter is divided into thirty lessons, each lesson being built around one central geometric principle.

In keeping with the modern trend in mathematics, there is definite coördination with algebra and trigonometry. The use of algebra is emphasized throughout the book. Trigonometry, as an extension of the study of similarity and the right triangle, is taken up in Lessons Twenty and Twenty-One. Part Two of Lesson Twenty-Two gives the better student a brief preview of Modern Geometry, through the idea of concyclic points. Logarithms are optional, being demonstrated in connection with numerical applications of Hero's formula.

The format is good with an excellent grade of paper and typing of ideal size.

The book is a radical departure from the customary geometry text, but meets unusually well the demands of students preparing for college. There is in the "laboratory method" much detailed reading to be done by the student, and the reviewer doubts whether an average class could do this satisfactorily without a good reading background and careful instruction. However, given a class that can read mathematics carefully, and is willing to experiment; in the conclusion one would have a class well initiated into the habits of accurate and precise thinking, transferable to non-mathe-

matical situations. Teachers will find it worth their while to examine this new geometry text.

H. GLENN LUDLOW

The Importance of Certain Concepts and Laws of Logic for the Study and Teaching of Geometry, by Nathan Lazar, Alexander Hamilton High School, Brooklyn, New York. Cloth. 66 pages. 17.5×26 cm. 1938. George Banta Publishing Company, Menasha, Wisconsin.

This book points out the possible utilization of geometry as a medium for making the pupils conscious of the existence of logical patterns of valid and invalid reasoning in mathematics as well as in the thinking of everyday life.

The concept of the converse of a proposition is analyzed, pointing out the shortcoming of the traditional definition, and another definition is recommended which does not have the defects discussed but does have both logical and pedagogical advantages.

The logical concept of the opposite of a theorem is discussed, and its comparative rarity in traditional text books is pointed out. The author recommends that the term opposite be replaced by the term inverse. The defects of the term "opposite" are pointed out and a definition of inverse is suggested along with the discussion of its advantages.

The meaning of the concept and the law of the contrapositive and its application to geometry are indicated. The meaning of the contrapositive of a theorem is given by illustrations. An historical study of attempts to introduce it into geometry texts is given. The law of contraposition is stated and proved, and its application to certain types of geometric problems usually requiring indirect proofs, and locus problems is shown. Its value to the mathematics students as a tool for discovering new theorems and its application to reasoning of everyday life is pointed out. Its application to "necessary and sufficient conditions" is also given.

This book should prove valuable to the college geometry student, the geometry teacher and to the prospective author of text books of geometry.

R. H. JONES

AIR-CONDITIONING INCREASES IONIZATION OF ATMOSPHERE

Air in an air-conditioned building contains twice as many ions as air out in the open, a study reported in the current issue of *Nature*, British scientific periodical, indicates.

Besides increasing the number of ions, the balance between positive and negatively charged particles in the atmosphere is changed, the report, prepared by F. Behounek of the State Radiological Institute of Prague and J. Kletschka of the Prague Municipal Electric Works, declares.

Though no study as to what this does to people working in such an atmosphere has been undertaken, "permanently increased ionization of air in an air-conditioned building may have a certain physiological influence," the scientists indicate.

Open air contains 300 positive ions per cubic centimeter and 260 negative ions, while air in the middle of an air-conditioned room contains 775 positive ions and 895 negative ions per cc., the two scientists have learned.

The number of negative ions within the air-conditioning apparatus is much higher, they point out, but the bulk of these are absorbed by the walls, thus almost restoring the balance.

SAHARAN ELEPHANTS

Elephant skeletons, closely resembling those of the existing African species, have been found in the Sahara, northeast of the Oasis of Bilma and 500 kilometers north of Lake Chad. They resemble also elephants shown in drawings on rocks in the same general region.

This discovery lends further support to the belief of scientists that at one time the Sahara was a well-watered big-game country.

VEINS AS IDENTIFIERS

Veins on the back of the hand are proposed as means of identification, like fingerprinting, by Dr. Enno Freerksen, of Giesen. He calls attention to the fact that the veins on every hand form a characteristic pattern and he claims that there are no duplicates, although there is strong similarity between the vein patterns in twins, as there is in fingerprints. Dr. Freerksen conducted most of his studies with the aid of infrared photography.

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